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Aspects of a Literacy of Infographics: Results from an Empirical-Qualitative Study

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Education

by

Lorna Stephanie Gonzalez

Committee in charge:

Professor Karen J. Lunsford, Chair

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December 2018

The dissertation of Lorna Stephanie Gonzalez is approved.

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ABSTRACT

Aspects of a Literacy of Infographics: Results from an Empirical-Qualitative Study

by

Lorna Stephanie Gonzalez

Over the past decade, infographics have become a ubiquitous genre—circulated in mass media, posted on walls in public spaces, shared on social media sites; and more recently, assigned as reading and writing assignments in academic classes. Their ubiquity and appeal as a visual representation of processes and data make them a promising genre for delivering instructional content and assessing student learning. However, few studies have explored the extent to which infographics are being used in disciplinary contexts and what conventions around this emergent genre are being enacted by those who interact with them. For these reasons, this dissertation was designed to include two concurrent studies—a questionnaire, surveying 80 upper-division undergraduate students, and a discourse-based interview study with seven doctoral, postdoctoral, and professional participants—in order to understand participants' familiarity with infographic texts and whether infographics are mediated by particular features and/or types of knowledge indicative of a literacy of infographics. Qualitative coding and descriptive statistical analysis revealed general familiarity with infographics. Participants in both studies confirmed their common presence in various contexts, including academic ones, where interview participants tended to

recognize infographics for their pedagogical affordances. However, undergraduates indicated low confidence in their ability to read/comprehend or create infographics and reported difficulty with particular elements of questionnaire exhibits. These results suggest that the literacy demands of infographic texts might be greater than other types of visual texts, challenging those of us in higher education to be more considerate of students' literacy needs in our evaluation, selection, and uses of pedagogical materials, and more deliberate in the types of experimentation we do with infographic genres.

The results from 80 questionnaire respondents and 7 interviews reinforce findings from other studies of data visualization literacy, suggesting that, despite their reported prevalence in participants' informational, social, and academic lives, infographic texts are *not* straightforward texts that anyone can read or easily create with an infographic generator.

The study's findings also suggest a theoretical extension to Lave and Wenger's (1991) *Community of Practice* theory and the *boundary objects* (Wenger, 1998) and *corollary genres* (Yates & Orlikowski, 2007) embedded within them. That is, the experimentation with infographics as boundary objects between disciplines and public or learning audiences, as well as their treatment as corollary genres in certain academic contexts, revealed a tension between pedagogical intensions, effective communication, and the traditional processes and practices in disciplines. Finally, this study serves as a case for those of us in higher education to evaluate rhetorical situations carefully and to consider infographic texts as presenting an *opportunity* to teach disciplinary processes and practices.

Keywords: Infographics, literacy, boundary objects, corollary genres, disciplines, communities of practice.

TABLE OF CONTENTS

CHAPTER I. INTRODUCTION

Introduction

We access and utilize informational graphics (hereafter referred to as *infographics*) every day without giving much thought to their ubiquity. As digital, multimodal texts, such as infographics, become more pervasive in public spaces, they are influencing other ways of writing and communication, which makes them productive, discussable, and worth studying. The past decade has seen an uptick in infographic texts present in people's receptive activity, where they are encountering infographics while performing receptive tasks, like reading and comprehending information in advertising and news reporting. Likewise, infographics are showing up in expressive activity, like creating and sharing quantified information in visual ways. One example of this is the infographic resumes that people can create on web sites, such as visualize.me, a resume-building site. People can also share these infographics with the click of a button on professional and social media sites, such as LinkedIn. The genre of infographics has also entered the academy, where they serve a range of functions, from communicating disciplinary information in a visual way (assigned as class readings, a receptive task), to representing student learning (assigned as assessments of learning, an expressive task) about a given topic (Poe, 2013; Bowen & Whithaus, 2013). As such, infographics make a relevant case for study as an emerging genre of academic discourse.

What are infographics?

In their most basic form, infographics are visual representations of information and data. Their displays range in complexity, from representing a single idea to working to persuade an audience, accomplished in text, numbers, and graphic design. Below, *Figure 1*

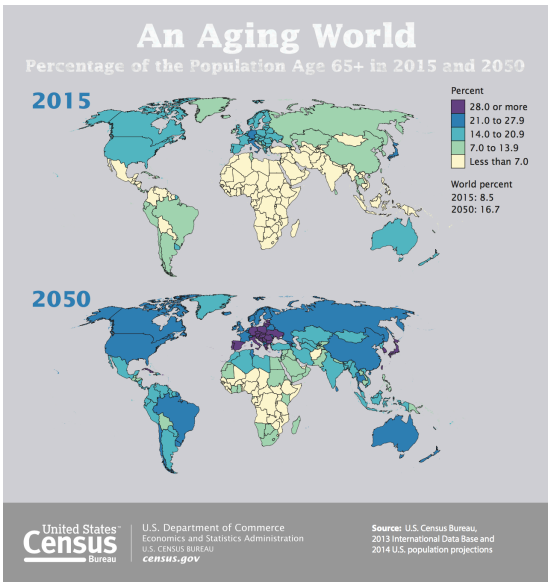

Figure 1. "An Aging World." U.S. Census infographic.

is an example of an infographic that communicates a single idea: what percentage of the world population is aged 65 and older, based on location, in 2015 and projected into 2050, according to the United States Census Bureau (He, Goodkind, & Kowal, 2016). Historically, the U.S. Census has made long, written reports of its decennial census findings available to the public. These reports contain charts and graphs derived from lengthy tables of information. An introduction and link to the 175-page report related to the "An Aging World" infographic in *Figure 1* are housed on the census.gov web site, and the report, itself, contains 79 figures, 28 tables, and 15 boxes. *Figure 1* represents a single factoid of information—mainly that, based on aggregated age data organized by geographic region, the percent of people age 65 and older worldwide is expected to double by 2050. *Figure 2*, below, shows the table containing this data before it was represented in infographic form.

Population Aged 65 and Over by Region: 2015, 2030, and 2050

Region	Population (in millions)			Percentage of regional total population		
	2015	2030	2050	2015	2030	2050
Africa	40.6	70.3	150.5	3.5	4.4	6.7
Asia	341.4	587.3	975.3	7.9	12.1	18.8
Europe	129.6	169.1	196.8	17.4	22.8	27.8
Latin America and the Caribbean	47.0	82.5	139.2	7.6	11.8	18.6
Northern America	53.9	82.4	94.6	15.1	20.7	21.4
Oceania	4.6	7.0	9.5	12.5	16.2	19.5

Source: U.S. Census Bureau, 2013; International Data Base.

Figure 2. Screen shot of data used for "An Aging World" Infographic. From He, et al., 2016.Many of the infographics housed on census.gov convey single snapshots of information, like this one, intended for public consumption (United States Census Bureau, 2017).

More sophisticated infographics apply visual, rhetorical techniques to appeal to a particular audience or to convey an intended narrative. A popular infographic from the

infographic curation web site, *Good.is*, called "Largest Bankruptcies in History[1]," uses the metaphor of a sinking ship to visually represent companies that filed for bankruptcy between 1987 and 2009 (the vertically-aligned dates on the left side). Because the sinking ship metaphor is a commonplace term for a failing endeavor, the authors assume that a large audience may be able to read, interpret, and understand the information presented in this infographic, which might be represented otherwise as a traditional timeline, bar chart, or table and peaking the interest of fewer people. The larger the vessel depicted, the more pre-bankruptcy assets were held by the company, adding a visual cue to the reader that large ships represent large companies with more to lose. However, this infographic contains some misleading information as well. The largest ship in the image, representing Lehman Brothers, waves a flag displaying $691 billion in pre-bankruptcy assets. This value is just over double that of the Washington Mutual "cargo" ship, which is represented much smaller than half the size of Lehman Brothers. Other rhetorical techniques sometimes found in infographics include juxtaposition (replacing connective arrows with graphic images to show a two-way link), metaphor (buildings look like bar graphs to convey an extended metaphor), simile (unified juxtaposition of two images), and antithesis (projections of change in environment or habitat), to name a few.

Although infographics share certain genre features like those described above, and range in complexity from simple factoids to esoteric concepts, they are a genre still developing—sometimes, improvising and experimenting with—representational norms and conventions. They draw from conventions of information and data visualization, graphic

[1] A visual representation of this infographic is available at https://www.good.is/infographics/transparency-the-largest-bankruptcies-in-history

design, and visual communication, but have no, single home in any one of those communities. For instance, in the computer science-based field of information visualization, or infovis, Ziemkiewicz and Kosara (2007) describe a helpful distinction between infographics and information visualization:

> The term [infographics] historically refers to visual presentation of data in the context of a newspaper or magazine, however. It may be thought of as a useful category covering those visual representations whose intent is communication of fixed information rather than interaction with fluid information: in other words, readability, but not active readability. Therefore, the main distinction between infographics and information visualization is the lack of interactivity (p. 4).

By this definition, infographics present research already conducted and are, therefore, static; whereas, infovis texts might include visual representations of information updated in a database on a more regular basis and may be more dynamic or interactive. An important distinction, here, is that infovis involves a visual display that interacts and changes accordingly with the data populating the database behind it. While infographics present information and can be interactive in different ways, they present a fixed dataset from information already gathered, collected, and organized. Despite these distinctions, the infographic genre and the field of information visualization are sometimes conflated, and experimentation with the evolving infographic genre continues to blur those lines.

One example of genre experimentation is the use of animations, or moving parts, within infographics. To create an animated infographic, a writer will use image software, like Adobe Illustrator, to create multiple, static images that can be layered on top of each other and timed to appear at particular intervals. One infographic, "An animated chart of 42 North American butterflies[2]," by University of Washington biology graduate student,

[2] To view the animated infographic, visit http://tabletopwhale.com/2014/08/27/42-butterflies-of-north-america.html

Eleanor Lutz, contains illustrations of butterflies found in six butterfly field guides. In the animated example, the butterflies flap their wings on the web page, adding visual interest to the scientific information about species, size, color, and region. In her explanation of the infographic, Lutz (2014) explains that her intention for this chart is as follows: "[the chart is] meant as a chart of decorative species illustrations rather than as an educational infographic" (para. 1). The butterflies as subject matter, highlighted geographic regions, measurements, physical characteristics, common name, genus, and phylum all constitute scientific representation that mediate this infographic text. The animation is interesting—each animated is timed to flap and flutter in different intervals and at different rates. The animation would act as disciplinary representation as well, however, if the flaps and flutters more closely represented the patterns of movement (flaps, flutters, glides, etc.) of the butterflies in nature.

Another example of experimentation with animation in the infographic genre is in instances where the animation conveys disciplinary information, rather than or in addition to visual interest alone. "The Four-Stroke Cycle," an animated infographic by Jacob O'Neal (Arndt, 2015), is an example of a single cylinder from a four-cylinder engine[3]. In it, familiar infographic features are present (e.g., text, image, etc.) and communicate mechanical engineering content, but the diagram is animated to reflect the rotation and vertical pumping motion of a functioning engine cylinder. When saved as a .gif, the rapid rotation between images creates an animation effect. A choice of design is in the way that the colors filling the cylinder chamber correspond to the colored numbers associated with the four-stroke

[3] The animated view of this diagram is available at this web site: https://animagraffs.com/how-a-car-engine-works/.

cycle depicted in the infographic. In this example, the animation is more than a device for visual interest; it mediates the graphic with disciplinary information from mechanical engineering. Experimentation with animation, in this way, adds another layer of non-discursive rhetorical activity to the infographic genre.

Other infographics are, themselves, animated. The infographic video, or infovideo, "The Fallen of World War II," by Neil Halloran (2016), presents military and civilian casualties delineated by country, battle, and cause. Each element of the video projects familiar infographic features, like quantitative information, graphic symbols, text, and other images, like photography, and effective design elements, like contrast in color and size, layout, etc. But, the continuous stream of data, voice narration overlay, and appearing/disappearing information add another dimension of affect and storytelling to the infographic genre. His infovideo can be viewed like a traditional video or as an interactive experience; thus, blurring the lines between infographics and infovis. Experimentation like this is being celebrated in public and academic communities alike: with Lutz seeing her work published in popular online and print magazines, including *Wired*, *Scientific American*, and *National Geographic*; O'Neal seeing his work featured in *The New York Times*, *Car Talk* radio show, and automotive blogs; and Halloran receiving awards for his work at South by Southwest and Information is Beautiful, as well as over 8.6 million video plays on vimeo.com.

The utility of infographics is in their potential ability to tell a story to an audience through a visual, multimodal representation of ideas and information. In his book, *Cool Infographics: Effective Communication With Data Visualization and Design*, infographics designer and data visualization researcher, Randy Krum (2014) describes the emerging

genre of infographics with this definition: “Today, the use of the word infographics has evolved to include a new definition that means a larger graphic design that combines data visualizations, illustrations, text and images together into a format that tells a story” (p. 6). By Krum’s definition, infographics merge research and narrative in a way that can connect with a broad audience, including a public one.

Where are infographics?

Infographics are becoming more prevalent in public discourses. Google Trends, a tool for analyzing terms or groupings of terms as they are entered into Google Search engines, will yield results that show a term’s popularity relative to itself over time. An

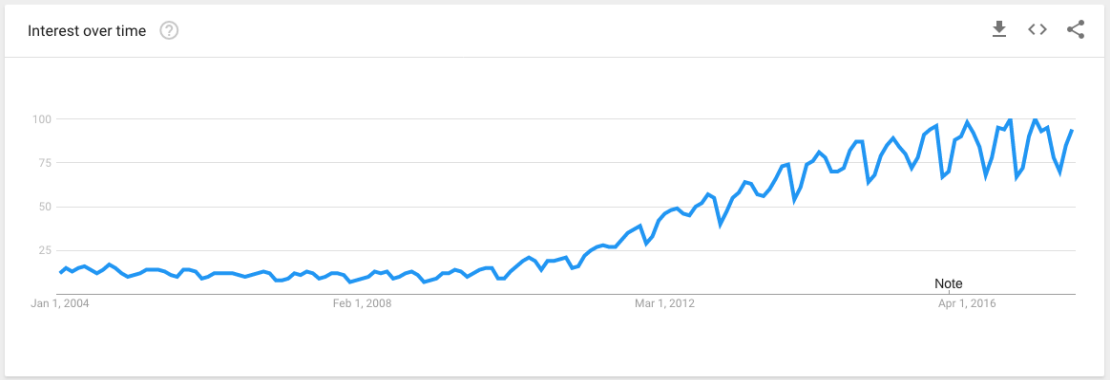

Figure 4. Screen shot of Google Trends search result for Infographic.

analysis of *Figure 4*, above, shows that, in Google search engines, the term *infographic* has seen increased interest between 2010 and the present. In May 2017, the term received a score of 99, which means that the term was 99% as popular as it was at its peak in November 2016, having risen substantially in use since 2010. Also part of the Google Trends results are topics and queries related to the initial search term, meaning that users who searched for *infographic* tended also to search for these related terms and topics in

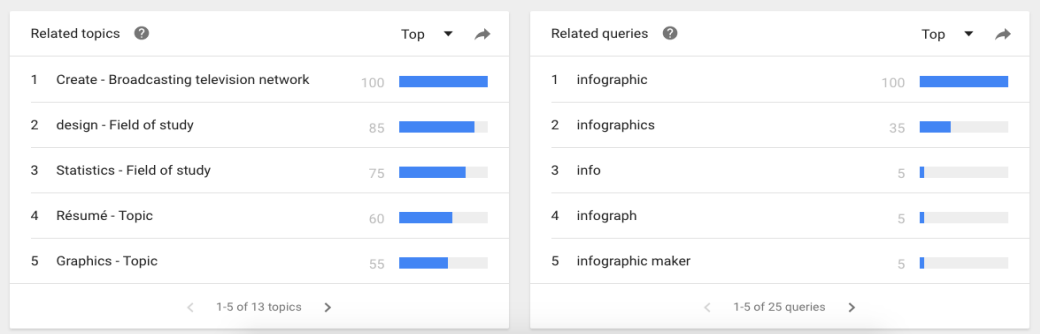

Figure 5. Screenshot of topics and queries related to Google Trends search for infographic.

Figure 5. It is notable that the term has been searched along with the fields of both design and statistics, as these are fields historically associated with their production and circulation.

Another analytical tool for observing a term's presence in public discourse is Google's Ngram Viewer, a searchable database that will display a graph showing how particular words or phrases are used in a corpus of books over a selected period of time (Google's available date range is 1500 to 2008). *Figure 6* shows that, between 1990 and 2000, there was a 359% increase in how often the term *infographic* was present in Google's corpus of books, relative to other terms present in the same corpus.

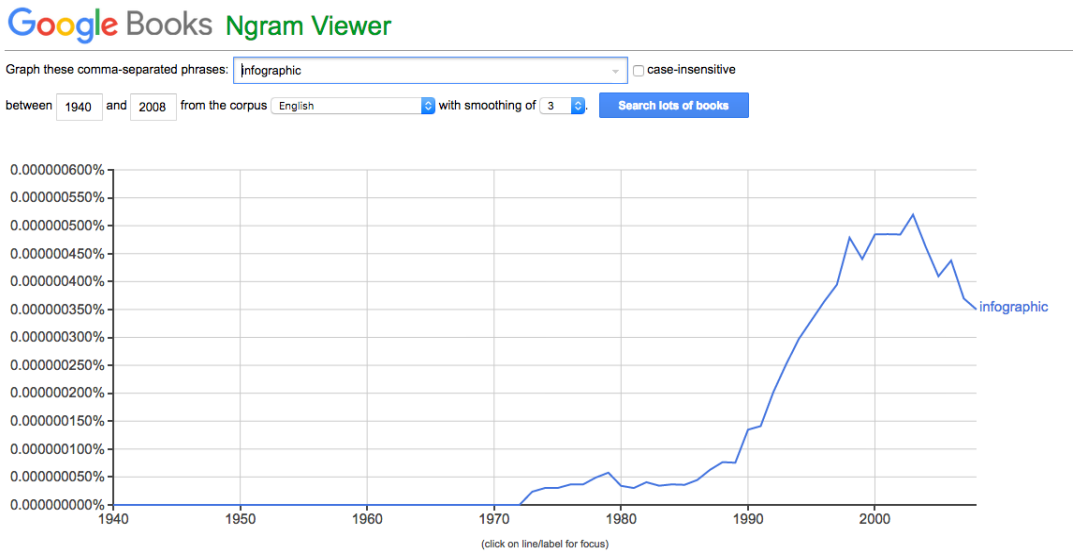

Figure 6. Google Ngram Viewer results for Infographic.

Infographics are most recognizable in journalism and media, but even this phenomenon has seen an upward trend over the past ten years. Beginning in 2010, the same time frame where the Google Trends graph showed an uptick in search popularity (*Figure 6*), the Fox News Network began linking web stories to external sites that housed infographics, and has posted 1077 articles linked to infographics since that time. *The New York Times* boasts an award-winning Interactive Department, including one such "gold medal" earned specifically for infographics and bestowed upon them by The Society for News Design (http://www.malofiejgraphics.com/awards/). *Forbes* published a 2013 web post about infographics for content marketing, suggesting that infographics can reach a "viral" audience faster than other marketing tools. *The New Yorker* publishes an infographics section, and online magazines, like *LifeHacker*, include infographics as a category of published content that is also widely circulated on social media. *The Washington Post* published "Teaching with Infographics" curriculum as part of the Newspaper in Education Program, funded by individual, corporate, and subscriber donations. Whether or not people know what infographics are, people who read online content or participate in social media are likely to have encountered those texts on an increasingly regular basis.

Infographic generators make it easier than ever before to produce an infographic with little data visualization, computer software, or artistic design experience. Start-up companies with investor backing have made their debut over the past decade, and clients ranging from large corporations to individual writers are making use of their services and templates. *Table 1* includes a non-exhaustive list of some of these resources available to an Internet-using public.

Table 1

Infographic Generator Companies and Basic Information

Founding or Launch Year	Company	Information
2003	Tableau https://www.tableau.com	Founded in 2003 by a PhD student and his advisor in Computer Science at Stanford, plus a team of grad students and an entrepreneur, brought together two sub-disciplines of computer science: computer graphics and databases. They created a drag-and-drop interface that would allow users to visualize their data with pictures. Tableau is proprietary & aimed at business analytics (the other generators, above, have a business component but are also used for educational and personal applications/projects).
2010	Killer Infographics http://killerinfographics.com/about-us	proprietary; based in Seattle; aimed as business presentations
2011	Piktochart https://piktochart.com/	tech startup w/investors in China (to start)
2011	VennGage https://venngage.com/	Infographic generator & templates
2011	Visual.ly https://visual.ly/	Large brands, like Visa, Ford, and Nike have used their services, one of which is infographics.
2012	Infogram https://infogram.com/	tech startup; 30 employees
2012	Easel.ly https://www.easel.ly/	7 employees; received 2015 award from American Association of School Librarians, "Best Web Site for Teaching and Learning"
2012	Infoto www.infotoapp.com	Infoto is a simple android app for mobile devices that allows a user to snap a photo, add information to it, and create an info-graphic.
	Dipity http://teachinghistory.org/digital-classroom/tech-for-teachers/24620	Dipity is a timeline builder created by the Roy Rosenzweig Center for History and New Media at George Mason University with funding from the U.S. Department of Education. Funded through the Office of Innovation and Improvement's Teaching American History (TAH) program (contract number ED-07-CO-0088).
2012	Canva http://www.canva.com	Canva is a graphic design and infographic generator founded by a graphic design instructor and two tech colleagues in response to the difficulties the instructor observed her university students were having.

Infographics in the humanities. In recent years, humanities and social sciences research has employed infographics for sharing research stories within their own disciplinary communities as well as with a larger public audience. One example of this is *The Humanities Matter!* Infographic, created by The University College London (UCL) Centre for Digital Humanities and 4Humanities, a public relations and advocacy initiative for the humanities. *The Humanities Matter!* infographic[4] was launched at an academic conference, *Digital Humanities 2013*, and drew from statistics and polling to provide a data-centered counterargument to public misconceptions about the value of the humanities. In his web post about the infographic, Alan Liu (2013), a preeminent digital humanities scholar, situated this text within a body of research and infographic work for the 4Humanities Humanities Infographics initiative. He invited readers to share the text online and added that print posters were mailed to "newspapers and magazines, national councils and commissions, public and private funding agencies, humanities centres and programs, and digital humanities associations and programs around the world" (Liu, 2013, para. 2). The 4Humanities Humanities Infographics initiative, of which he writes, includes "Infographics Friday" online blog posts. In this way, the humanities are using infographics as a way to share research and promote their own relevance as a field to the public and stakeholders.

Infographics are making their way into academic conferences, where there is already a long-standing tradition of poster presentations. In the humanities, for example, the *Digital Frontiers 2017* conference, described on the "Call for Participation" as "an annual conference that explores advances in research in humanities and cultural memory through

[4] To view the *Humanities Matter!* infographic, visit https://4humanities.org/wp-content/uploads/2013/07/humanitiesmatter300.pdf

the lens of digital scholarship, technology, and multidisciplinary discourse" ("About" section, para. 2), includes a "Call for Submissions for Posters and Infographics," expanding the traditional poster presentations category to include this new genre. University of California, Berkeley's Digital Humanities online resource guide for creating poster presentations for academic conferences encourages writers to follow certain conventions, like including a research question, data collected, methods, next steps, etc., but the resource guide also encourages creativity, adding, "Don't be afraid to be creative, either! You can use some effective infographics or PowerPoint decks as a model" ("Structure of a Poster" section, para. 4). Even the Modern Language Association (MLA), one of the most recognizable membership organizations in the humanities, has added poster sessions as one of two, new session formats to debut at the 2018 convention. Though infographics are not mentioned specifically in the poster format description, posters are described as "projects that may or may not be digital" and that "[i]ndividual members may propose projects or demonstrations […]" ("Poster Sessions" section). By expanding the academic conference poster session tradition to include infographics, it is evident that the humanities are employing infographics as valid scholarship within the academic community, as well as a way to foster public engagement with the humanities.

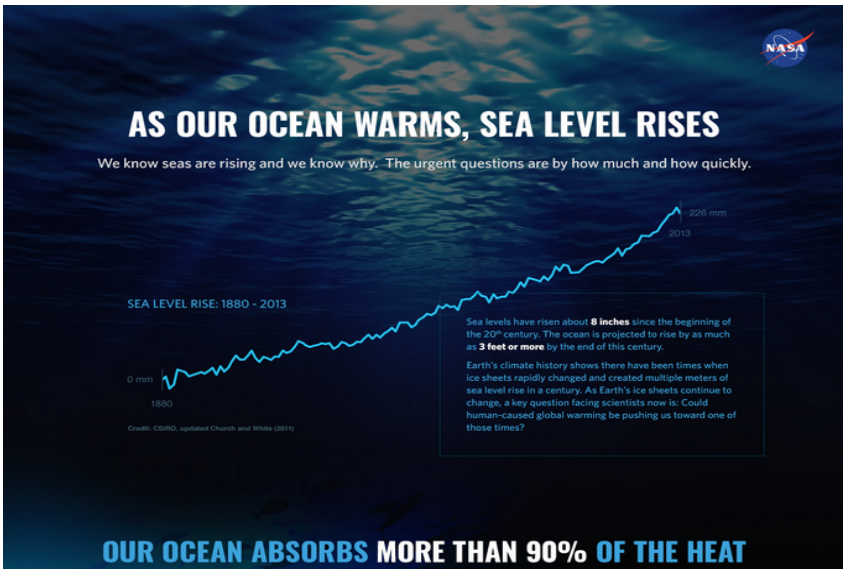

Figure 7. Screen shot excerpt of JPL/NASA climate change infographic.

Infographics in the sciences. Science has a long tradition of using graphs, charts, diagrams, icons, drawings, and other visual representations to communicate scientific information. In recent years, however, infographics have become one genre of choice for communicating metadata to broader audiences, as attempts to educate people about issues on which there is a large body of work. For example, the National Aeronautics and Space Administration (NASA) publishes infographics to synthesize large bodies of research on climate change. *Figure 7* (above) contains an excerpt from NASA and Jet Propulsion Laboratory's infographic, "Sea level rise[5]." On their web site, this infographic is accompanied by links to fact sheets, graphics, and other resources, but this long, vertical, image comprises two-thirds of a reader's screen space and begins with a haunting photographic background that gives the reader the perspective of looking up from below the surface of the dark sea water. This infographic, and others like it, synthesize climate data

[5] To view the entire "Sea Level Rise" infographic, visit https://climate.nasa.gov/climate_resources/125/infographic-sea-level-rise/

from multiple studies in order to demonstrate, using data and engaging visuals, that climate change is a real, scientific phenomenon, not a controversial political issue.

Infographics are not simply for public interest in science research; they can be utilized to inspire action. In their book, *Communicating Your Research with Social Media: A Practical Guide to Using Blogs, Podcasts, Data Visualisations and Video*, Mollett, Brumley, Gilson, and Williams (2017) describe one such example from Great Britain. In 2014, the British Cycling Federation published an infographic to promote the idea that government investment in cycling could save money and promote health. This infographic was intended for policy-makers and politicians, and was well-timed with a parliamentary debate on cycling. Combined with extensive media coverage and social media viewing and sharing, Mollett et al. add that this infographic made a policy impact because parliament did agree to make an investment in cycling and members present at the debate indeed cited references directly from the infographic (p. 126-127). In this way, infographics can play a positive role in science communication and public policy.

Infographics in Research and Scholarship. Infographics are also being used to tell research stories *within* disciplines, themselves. In the book and web site, *The Meaningful Writing Project* (http://meaningfulwritingproject.net/), composition researchers, Michele Eodice, Anne Ellen Geller, and Neal Lerner (2017) present the story of their research, which involved a cross-institutional study of senior undergraduate students' meaningful writing experiences during their collegiate tenures. Their book contains chapters and their web site includes a navigation menu to familiar sections of published, scholarly work, like "Study Design," "Findings," and "References," but there is an additional chapter or menu tab for a

page, called "Infographic Data[6]." The "Infographic Data" book chapter and web page tells the story of Eodice, et al.'s research in familiar infographic form, containing an organized patchwork of text, charts, icons, etc. that highlight important information. Their study was not about infographics, but an infographic was used to deliver information about the study. Using an infographic to convey research methods and findings is an act of experimentation with traditions for reporting research and treatment of infographics as a valid genre for this kind of representation to a community of peers. Further examination of infographics in writing studies, more specifically, will occur in the Theoretical Framework and Literature Review of this proposal.

Infographics, themselves, are becoming a valid site for academic research, particularly in the fields of science, education, and visual communication. The National Science Foundation has awarded funds for infographics research seven times since 2014, totaling $2.5 million. Five of the awards associate infographics with visual literacy and involve research that aims to teach students how to communicate their understandings of disciplinary concepts using infographic representations (National Science Foundation). *Visual Communication Quarterly*, a scholarly journal, yields 12 results for infographic research articles since 2009, including three articles that focus on effects of infographics on readers, with terms like, "The role of," "The influence of," and "The Effectiveness of [infographics]" (http://www.tandfonline.com/loi/hvcq20). As a disciplinary genre, infographics are gaining value and validity worthy of new scholarship.

[6] To view the "Infographic Data" infographic, visit http://meaningfulwritingproject.net/?page_id=271

Problem Statement

Because infographics are most visibly circulated in mass media, they are treated by the media as a straightforward genre that anyone can read. In fact, *The Washington Post*'s Information Designer, Wilson Andrews, treats that universal readability as a goal. In an interview with *Forbes*, Andrews says, "So much of visualization is creating a clear and nearly-instant understanding of the main story that is being told" (Thomas, 2011). Likewise, infographic generators and templates sell the idea that infographics are a genre than anyone can create. Even academic literature lauds infographics as an effective instructional resource (for students to read) and learning activity (for students to write). In one example, Christopher Hall (2016), a journalism instructor at Sheffield Hallam University, shared how infographics were used as an instructional resource to introduce core concepts and supplement additional film and media production course information to undergraduate students, adding that his course received external recognition for utilizing infographics in this way. Science education researchers, Gebre and Polman (2014) have incorporated infographic composing into their course design by having students collaboratively design and critique scientific infographics. Their goals are "engagement in science literacy" and "representational competence" (p. 2669). Treated as such, infographics give the appearance of a useful medium for delivering academic content and demonstrating a certain degree of content-area competence.

However, there is no dearth of research about the challenges of reading visual and quantitative texts. On the contrary, there a misconception about students' preparedness for reading and writing complex, disciplinary, and infographic texts. Library scholars, Duke and Asher (2012) contend that many students enter college unprepared or underprepared for

effectively using and critically assessing resources for their academic course work. Though computers, tablets, and software applications are designed (and redesigned) with user-facility in mind, literacy theorists suggest that these digital technologies complicate literate practices (Berry, Hawisher, & Selfe, 2012) not only because such practices require multiple literacies, but also because these technologies change more quickly than other contexts in which we write. In the past ten years, note-taking technologies in college classes have ranged in form from items such as pad and paper, laptop computer, and tablet computer, moving from pen strokes to keystrokes to finger swipes to take notes in class. With more access to the Internet and more tools for creation and publication, literate activity is not just about retrieving and parsing through information; rather, information is being remediated (Bolter & Grusin, 1999), rearticulated (Johnson-Eilola, 2005), and constructed in various ways (Kress, 2003; Daley, 2003; Messaris, 1994), which has instructional consequences for courses in which students are asked to receive and express information in these ways. On the one hand, students have generally more access and experiences with digital writing technologies than ever before; but on the other hand, their access and experiences do not equate to proficient ways of thinking about and using technology for academic or professional purposes. Although some frameworks exist for guiding pedagogical decisions about course design (e.g., Koehler & Mishra, 2009; Garrison & Vaughan, 2008; Wiggins & McTighe, 2005; Meyer, Rose, & Gordon, 2016), recent scholarship in computers and composition, more broadly, and infographic or other types of digital composing, more specifically, have been heavily steeped in action research or process pedagogy.

However, we know that expectations for student learning in higher education include preparation for civic and professional life beyond college. According to an interdisciplinary

cohort of scholars from education, linguistics, semiotics, and others, called the New London Group (1996), "If it were possible to define generally the mission of education, one could say that its fundamental purpose is to ensure that all students benefit from learning in ways that allow them to participate fully in public, community, and economic life" (60). Nearly twenty years later, this kind of participation includes what education researchers, Trilling and Fadel (2009), call "knowledge work" (p.3), which they define as "expert thinking and complex communicating," (p. 8), with a strong emphasis on digital, multimodal ways of producing, consuming, and distributing information.

Likewise, learning researchers Garrison and Vaughan (2008) state that college and university students expect their learning experiences to be relevant and engaging (p. 6). Although many instructors seek to address such demands with learning management systems and online reading and writing assignments of various kinds, it is unsafe to assume that students have a wide range of previous academic experiences with technology or that they are proficient with technology in ways that transfer to their academic work, especially academic writing. To this point, Hattwig, Bussert, Medaille, and Burgess (2013) argued that even though the current generation of college students were likely to have many experiences participating in a highly visual online culture, they do not necessarily have the skills to engage critically and effectively with multiple media in an academic environment. Therefore, it is important to study students' experiences with writing technologies, multimodality, and infographic texts in order to design instruction that integrates these things from an informed perspective. Further, comparing student experiences, knowledge, and perceptions against more experienced academicians could reveal ways of thinking and

practicing that go unnoticed in process studies, which typically examine how participants navigate their composing processes.

One thing we do not know about infographics is whether and how there is a specific literacy of infographics. Does a person's disciplinary or professional affiliation impact their reading or creation of an infographic text? Research in the science of learning has shown that expertise is domain-specific and does not necessarily transfer from one domain, like biology, to another, like chemistry (Bransford, Brown, & Cocking, 2000). More than a journalistic factoid, an advertising gimmick, an out-of-the-box resume, or a fancy way to represent quantitative data, infographics are an info-visual product that involve expressive and receptive activity, using context-specific ways of thinking and doing. That is, to compose an infographic requires representing information, in graphical and textual forms, in service of a narrative or an argument. This representation is an expressive task and requires knowing when a situation calls for information to be presented that way. Likewise, sociocultural theorists argue that people are *enculturated* into particular ways of reading and writing through apprenticeship to social practices (Lankshear & Knobel, 2008). Reading is a receptive task. Gee, Hull, and Lankshear (1996) describe this apprenticeship as it relates to the notion of literacy:

> A way of reading a certain type of text is acquired *only* when it is acquired in a 'fluent' or 'native-like' way, by one's being embedded in (apprenticed as a member of) a *social practice* wherein people not only *read* texts of this type in these ways but also *talk* about such texts in certain ways, *hold certain beliefs and values* about them, and *socially interact* over them in certain ways…Texts are parts of *lived talked, enacted, value-and-belief-laden* practices carried out in specific places and at specific times (p. 3).

What happens, then, when a ubiquitous public genre—one that, itself, is still emergent—is appropriated by a particular community, like an academic discipline? This introduction has

identified three ways infographics are treated: 1) a ubiquitous public genre; 2) a boundary object between disciplines and public audiences; and 3) disciplinary genres. What is not known is how and to what extent infographics are received in these ways by academic readers and writers.

Research Questions

Three questions guide this study:

1. How familiar are participants with infographics?
2. Is there a literacy of infographics?
    a. How and to what extent do participants identify certain features of infographic texts as *common to a genre of infographics*?
    b. How are infographics mediated by knowledge of domain, design, and/or topic?
    c. How and to what extent do readers identify infographic texts as *boundary objects* between disciplines and a public audience?
3. What, if any, differences exist between undergraduate and graduate students in their familiarity with infographic texts?

To investigate these questions, a two-part, exploratory research study was designed and executed in January through April 2018. This study aimed to test for two types of participant expertise: 1) experience and familiarity with infographics; 2) aspects of a literacy of infographics, marked by elements common to the genre and mediating factors, like domain, design, and topic.

CHAPTER II. REVIEW OF LITERATURE

Introduction

The introduction to this dissertation provided a broad overview of the many ways that infographics are represented and evolving as a genre. The sections that follow begin with an infographic framework and taxonomy to form a working definition of infographics at the time of this particular study. The infographic framework was used to inform descriptions of artifacts throughout this dissertation, as well as to help form the analytical framework for interpreting and reporting results of the study. The infographic framework is followed by the theoretical framework and review of literature that informed the conceptual design and research rationale for the present study. Concepts from communities of practice theory and genre theory informed the framing of the research questions about infographic texts as ubiquitous genres, corollary genres, and boundary objects between disciplines and publics. Following the infographic framework, theoretical framework, and literature review, this work continues with the research methods, analytical framework, report of results, and discussion of conclusions.

Defining Infographics

The Introduction to this dissertation contained several examinations of definitions and types of exhibits that constitute a representative genre of infographics, noting great variation and experimentation with the genre as it continues to emerge. Because this present study aims to understand aspects of a literacy of infographics, including participants' familiarity, encounters, and interpretations of them, I created a framework for understanding infographics in order to communicate a point of departure for further discussion of the study and results. To construct the framework, I drew from two working definitions of

infographics as well as an existing framework of data visualization used previously for similar studies (Börner, Maltese, Balliet, & Heimlich, 2015; Börner & Polly, 2014).

Definition

As stated previously in the introduction to this dissertation, infographics, at their most basic, are visual representations of information and data. Infographics designer and data visualization researcher, Randy Krum (2014), defines infographics as a multi-dimensional genre: "Today, the use of the word infographics has evolved to include a new definition that means a larger graphic design that combines data visualizations, illustrations, text and images together into a format that tells a story" (p. 6). With this definition, infographics can be understood to have three dimensions: one dimension of visualized, quantitative information or data; a dimension of design that includes illustrations, text, and images; and a dimension of storytelling through the composition of those previous elements on a single canvas.

Another working definition of infographics used to inform this research comes from Polman and Gebre (2015), in their study of experts' appraisals of infographics for use in teaching this genre to students of science. They offer the following definition: "Infographics are visual representations of complex data and ways of communicating insights in visual form" (p. 868). Important to this definition is both the idea that the data represented can be complex and the idea that infographics communicate insights, suggesting a story-telling dimension of author-driven decision-making.

Together, these two definitions of infographics comprise a working definition used to frame this study's methodology. Infographics are framed by three dimensions of visual communication:

- Visualization of complex data
- Design
- Story

Visualization concerns the way that data sets or other information (e.g., relationships, processes, etc.) are represented in graphs, charts, maps, and other graphic forms. Design includes the ways that text, illustrations, and images are used as part of the composition, but it also includes some graphic design choices, like color, font, and spacing, which have been shown to have communicative qualities (Williams, 2008). The storytelling dimension includes the insights or message that is conveyed and how the visual elements on the canvas function to achieve this message, sometimes using rhetorical techniques, like metaphor, simile, and juxtaposition. For the purposes of this research, an artifact absent some elements of design or storytelling might just be a traditional graph, chart, or other data visualization.

Visualization

Given a complex data set, process, or relationship logic, a person creating an infographic has many layers of decision-making in the creation and composition of an infographic, including decisions about the visualization output. Statistical software, like SPSS and Qualtrics, two applications used in this study, include output options that can be used to convey visualized results. The visualization method selected will impact the way the information is read and interpreted by other people, even before any additional design choices are made, like size, color, use of metaphor, and position, to name a few. For the purposes of this research, a visualization taxonomy has been adopted from Börner, Maltese, Balliet, and Heimlich (2015) and Börner and Polly (2014) to list the types of visualizations present in the infographics selected for this study, as well as the types of messages such visualizations are meant to convey. These visualization types include: charts, graphs, maps,

and network layouts. Because infographics involve more elements than a single data visualization, this taxonomy includes three additional visualization types: list text, repeated charts, and mixed charts.

Charts. According to the visualization framework used in Börner, Maltese, Balliet, and Heimlich (2015), "Charts visually depict quantitative and qualitative data without using a well-defined reference system" (p. 3). They are preferentially used to represent data that answers "what," or topical questions and some relationship questions (Börner & Polly, 2014, pp. 114-115). A bubble chart, for example, might display quantitative information about global incarceration rates, and the size of the bubbles is arbitrary, but the relative size of one bubble to the next might depict their relationship to each other. *Figure 8* depicts a generic representation of a bubble chart, generated with the built-in visualization tools present in this version of Microsoft Word.

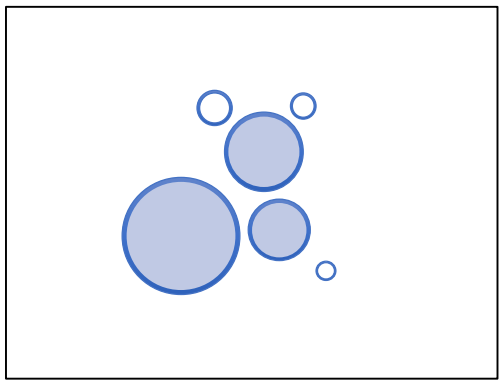

Figure 8. Example bubble chart.

Maps. Maps and diagrams contain specific geospatial information and answer "where" questions (Börner, et al., 2015, p. 3).

Graphs. A graph is more dependent than a chart on a defined reference system (like an x- and y-axis), and graphs are preferentially used to represent temporal or "when" questions, according to Börner, et al. (2015). They can also represent processes, "how"

questions, and timelines because they contain clear starting and ending points that contain the data within them. *Figure 9* contains a generic example of a stacked, horizontal bar graph.

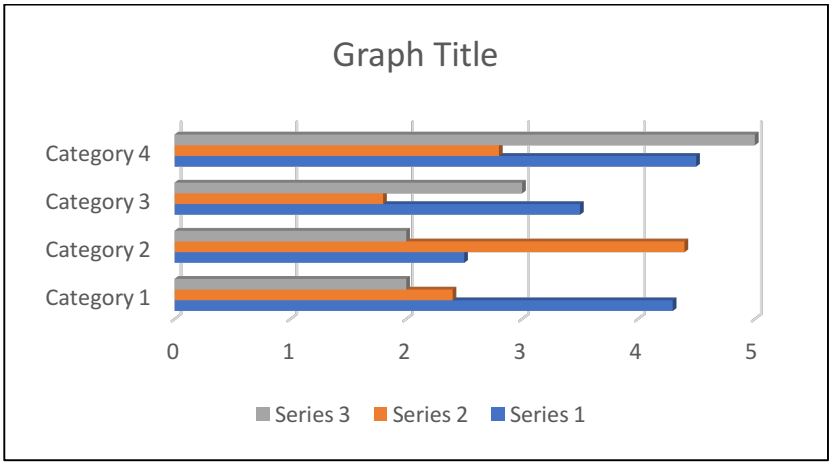

Figure 9. Generic example of a stacked bar graph.

Network layouts. Network layouts depict relationships and answer "with whom" questions. According to Börner, et al. (2015), "Network graphs use nodes to represent sets of data records and links connecting nodes to represent relationships between those records" (p.3). *Figure 10* contains a generic representation of a network layout.

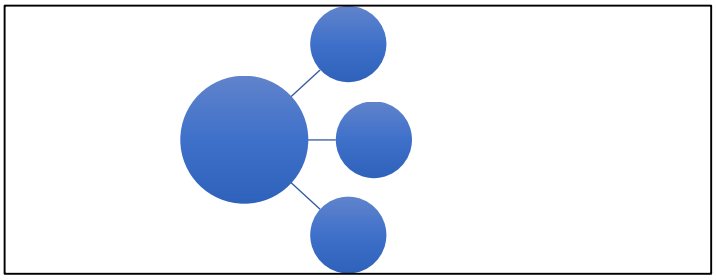

Figure 10. Generic representation of a network layout.

Infographic visualizations. The framework listed above contains familiar visualization types present in infographics. But, there are more to infographics than those visualizations, alone. Some infographics contain multiple data visualizations on a single canvas. Paul Van Slembrouck (2012), a blogger for the curated infographic web site, visual.ly, analyzed 30 infographics that received the most unique page views on the visual.ly

web site between 2011 and 2012, in order to understand, in part, what types of data visualizations were present in the most-viewed infographics. He found that, with the exception of three outliers, six visualization types were present in the infographics that had received the most page views during the brief research period. These visualization types are listed with the Börner, et al. (2015) taxonomies in parentheses, when relevant: 1) process graph (graph); 2) list text; 3) single chart (map or chart); 4) timeline (graph); 5) repeated chart; 6) mixed charts (Van Slembrouck, 2012, "Six Design Types" paragraph).

The three visualization types that were not present in the visualization taxonomy were list text, repeated chart, and mixed chart, all of which are present in some of the infographic artifacts utilized for this study. A *list text* will tend to involve a bulleted or numeric list of independent statistics or units of information. They tend to answer topical ("what") questions in a list, rather than a chart. A *repeated chart* will include multiple iterations of the same visualization type on a single canvas. For example, a bar graph depicting income data for men and women might be repeated on a single page to represent different time periods or professions. Instead of seeing each bar graph independently, as one might do on an interactive visualization or in a static report, the data is visualized and represented in one place, with a consistent design across variables. Finally, *mixed charts* will combine visualization types on a single canvas. An infographic about UFO encounters, for example, might contain a map, a bar graph, and list text, all in one exhibit.

This working definition and taxonomy of infographics is not comprehensive, as there is greater variety in this emerging genre than what was investigated in this study. Likewise, one question under investigation for this study is whether participants identify certain elements common to a genre of infographics. In order to avoid bias in the study design,

infographics were selected with attention to the breadth of visualization types, the design choices, and the content represented. However, the definitions offered by Krum (2014) and Polman and Gebre (2015), as well as the visualization types explained by Börner, Maltese, Balliet, and Heimlich (2015) and Van Slembrouck (2012) locate this study within an infographic framework that includes three dimensions of analysis (visualization, design, and story) and multiple visualization types (including charts, graphs, maps, network layouts, list text, repeated charts, and mixed charts).

Theoretical Framework

Two frameworks form the conceptual basis for this study: 1) *communities of practice*, for considering the emergence and evolution of infographics in educational contexts; and 2) *genre*—a socially "recognizable, self-reinforcing form of communication" (Bazerman, 2014, p. 316)—for understanding infographics as part of a social, communicative practice. Both frameworks offer a sociocultural perspective for our understanding of human activity, learning, and development as socially and culturally constructed—and changing—over time. In this section, I will demonstrate that, as an emerging genre in and of itself, infographics function sometimes as a *corollary genre*—a variation of an established genre that is treated as a valid substitution, and sometimes, particularly in disciplines, as a *boundary object*—an artifact, document, or organizing concept brought in to a community of practice by a "broker" (Wenger, 1998). These concepts will be parsed out, exemplified, and then applied to questions that comprise aspects of infographic literacy explored by this study: To what extent do participants respond to infographics with attention to their common genre features, to what extent are infographics

mediated by participants' knowledge of domain, design, or topic, and to what extent are infographics recognized as boundary objects or corollary genres?

Communities of Practice

Literature on communities of practice is influential in discussions about mediated knowledge and meaning-making because community of practice theory is a social theory about human activity and learning. Wenger, McDermontt, and Snyder (2002) define communities of practice as "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (p. 4). Researchers have identified communities of practice as sites where members share particular values, beliefs, histories, attitudes, ways of making meaning, and ways of expression. Emphasizing that they are not just interest groups, or groups of people with shared knowledge or skills, Wenger (2009) explains that three, crucial characteristics comprise communities of practice: 1) domain, "a shared competence [in a domain] that distinguishes members from other people;" 2) community, "joint activities and discussions, help[ing] each other, and shar[ing] information;" 3) practice, "a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems" (pp. 1-2). These communities are familiar to us, says Wenger and colleagues (2002), because we belong to many of them, some occasionally or peripherally and some regularly or recognizably.

Academic disciplines are an example of a community of practice because they share subject matter, or conceptual knowledge, and traditions for consuming and communicating knowledge. Compositionist, Michael Carter (2007) uses the term, "ways of knowing, doing, and writing in the disciplines" (p. 385), to describe conceptual and procedural knowledge as

practices shared by members of disciplines. He draws from the example of a lab experiment and the production of a lab report as a scientific way of doing and knowing:

> It is primarily in the lab report, however, that doing becomes knowing. More than merely evidence of having completed the lab and having found the right answers, the lab report frames the doing as a scientific way of knowing: introduction, methods, results, discussion; establishing a hypothesis, testing the hypothesis, accumulating evidence related to the hypothesis, determining whether or not the hypothesis is accepted and why. It provides an opportunity for students to reflect on the relationship between the lab and the scientific concept of the lab and to frame the doing of the lab in the structure of scientific reasoning (Carter, 2007, p. 388).

Actions like scientific reasoning and historical thinking, for example, are situated ways of knowing and doing. In disciplines, ways of knowing and doing are reflected in the histories and traditions of academic scholarship, teaching and learning, and public engagement—these are disciplinary practices.

Wenger (2012) argues that such practices comprise the boundaries of communities of practice:

> Learning as the production of practice creates boundaries, not because participants are trying to exclude others (though this can be the case) but because sharing a history of learning ends up distinguishing those who were involved from those who were not. They share an enterprise, an understanding of what matters, relationships, as well as the resources that their history has produced (p. 3).

The implication of this is that, within communities, texts and text types may be taken up differently. Goffman (1974) refers to this difference as a *frame* through which members of specific professions, cultures and subcultures, and other groupings develop ways of reading and meaning making that reflect shared contexts, traditions, and experiences. The idea is that a single text *may* produce different readings, depending on the frame a reader brings to a reading. Returning to disciplines, specifically, Carter (2007) draws from genre theory to locate these differences in framing present in texts, or, "categories of knowing, doing, and writing that cut across disciplines but may be inflected differently in different disciplines

and in different contexts" (p. 394). This point, that disciplinary differences may be inflected in the way people interact with genres, informs one, informal hypothesis of this study: that there may be disciplinary influences in participants' readings of infographic texts.

Further, Carter draws from the work of influential genre theorists, Miller (1994), Bazerman (1994), & Russell (1997) to situate his lab report example within the concept of a *genre set*, or a collection of related genres. In Carter's example, the lab report may be seen as one possible genre produced in an academic situation that calls for a written product; other possibilities include scientific papers, poster presentations, or project proposals (Carter, 2007, p. 393). From the perspective of disciplines as communities of practice, what counts as a valid genre in a genre set and how knowledge is reified (Wenger, 1998), then, depends largely on the domain, community, and practice (Wenger, 2009) described earlier in this section. The consequence for the present inquiry is *whether and in what ways infographics count* as a valid genre in academic disciplines. That is, there are cases of infographics treated as a genre that transmits a discipline's conceptual knowledge to a learning audience (e.g., Hall, 2016); there are cases of infographics treated as a genre that fosters public engagement with the discipline (e.g., Liu, 2013); and, there are cases where infographics show up to communicate research stories within communities of practice (e.g., Eodice, et al., 2017). But, what is not known is how they are received by academic audiences and to what extent they draw from or contribute to disciplinary traditions for ways of doing and knowing.

Relative Expertise. Viewing disciplines as communities of practice helps to frame the way expertise is observed and discussed in this study. As Wenger (2011) explains where the term, "communities of practice" came from, he describes a dynamic apprenticeship:

> People usually think of an apprenticeship as a relationship between a student and a master, but studies of apprenticeship reveal a more complex set of social relationships through which learning takes place mostly with journeymen and more advanced apprentices. The term community of practice was coined to refer to the community that acts as a living curriculum for the apprentice […] And of course, learning in a community of practice is not limited to novices. The practice of a community is dynamic and involves learning on the part of everyone (p. 3-4).

Another way to think about learning and expertise within a community of practice is that it is *relative* to members' skills, knowledge, and experiences. An undergraduate student, for example, might have many previous encounters with visual texts, like graphs or diagrams, but is likely to be less experienced than a graduate student or postdoctoral scholar to have encountered information presented that way for particular, discipline-specific purposes, like representing historical data or a complex concept, like gender. In a study of how undergraduate and graduate students constructed meaning while reading poetry, Peskin (1998) observed relative expertise in the way participants employed particular strategies to make sense of a poem, recognized certain domain content present in the poem, organized their knowledge about literary works more broadly, and recognized certain rhetorical cues to meaning. Even experienced undergraduate readers were less experienced than the graduate students with this particular type of reading task.

Students, in their apprenticeship to disciplines as communities of practice, encounter many genres and genre sets because much disciplinary activity occurs though and with texts. Paré, Starke-Meyerring, & McAlpine (2011) describe this apprenticeship to disciplinary and professional discourse as a "path toward membership" (p. 219). They write:

> […] undergraduates are eavesdroppers, listening in on the disciplinary conversation and reporting it back to the professor (an actual member); Master's students are ventriloquists, able to sound like participants, but really only channeling the voices of the true members; doctoral students—if they are fortunate—find themselves increasingly involved as participants in work that matters, in work that will be public and that might affect others (p. 219).

By this spectrum of expertise described by Paré, et al. (2011), if infographics draw from or contribute to disciplinary traditions for ways of doing and knowing, then it stands to reason that graduate and postgraduate scholars will have more expertise relative to undergraduates in the ways infographics are mediated by disciplinary activity and knowledge.

Genres in Disciplines

Embedded in Community of Practice theory, and referenced in the previous section, is the notion of *genre*, which is more than the written outcomes (e.g., lab report, poster presentation, etc.) of the scientific lab experiment from Carter's example. In Bazerman's (2014) chapter about how texts organize activity and people, genre is understood as a social structure that is coordinated and produced through members' ongoing communicative practices (p. 316). It is what happens, for example, "if we find a certain kind of utterance or text seems to work well in a situation and be understood in a certain way, when we see another similar situation we are likely to say or write something similar" (Bazerman, 2014, 316). Disciplines refer to this kind of thinking, or "way of knowing" (see Carter, 2007) as procedural knowledge (Anderson, 1995). Reinforced genre use in particular situations (e.g., Carolyn Miller's *rhetorical situation*, where particular situations call for the use of particular genres) shapes the way people will communicate in particular situations.

As academic institutions, disciplines have many genres and genre sets. In their book, *Genre Relations: Mapping Culture*, linguists, Martin and Rose (2008) identify genres as academic language functions (e.g., things people *do* with language in its many forms—spoken, written, gesture, etc.) and provide examples of genres common to academic disciplines. The non-exhaustive list, below, contains a summary of some of the genres they identify in history:

- Recount – temporal connections and concrete participants
- Account – causal connections of events and participants (e.g., written retellings)
- Explanation – complex factors and consequences of events
- Exposition – positions that need to be supported with evidence

Martin and Rose recognize that these language functions (e.g., recount, explain, etc.) will be enacted differently in the genres of different disciplines. This non-exhaustive list contains a summary of some of the similar genres they identify in science:

- Recount – list the procedures for an experiment
- Define and relate – explain scientific concepts
- Explain or justify – apply scientific reasoning
- Evaluate or construct – make scientific arguments

By learning the genres within a community, like a discipline, Bazerman says, "in this way one learns to think and act as a member of one's profession or discipline" (Bazerman, 2009, p. 289). In history, this would mean that a person would *recount* an event by reporting information contained in public records of specific people and events, for example; while, to *recount* in science, one might list the procedures for a laboratory experiment. The ways of enacting this genre are different in these two disciplines.

Once again, this notion of difference supports Carter's (2007) argument about how genres should be treated in disciplines. He writes, "we need to be able to conceptualize writing in the disciplines in a way that is grounded in the disciplines themselves, a viable

alternative to an understanding of writing as universally generalizable" (p. 387). In an examination of infographic genres, this idea matters because it lends the hypothesis that infographics might be mediated differently by disciplinary knowledge and that these differences might be inflected by readers from different disciplinary associations. This is also particularly consequential for the use of infographics in the work of disciplinary teaching, learning, and research scholarship, where infographics are, at present, treated as a-disciplinary, generic texts in and of themselves.

Corollary Genres. Because genres are part of a system of social activity, they evolve, change, and can even be transformed over time. Hanks (1987), quoted in Schryer (2002), refers to genres as flexible communicative forms, "produced in the course of linguistic practice and innovation, manipulation, and change" (p. 81). To illustrate this point, Bazerman draws from the example of newspaper stories, in the way that they "now have a different 'feel' than those of a century ago—which can be attributed to changes in the understandings of articles—such as the expectation of rapid communication, the quick dating of stories, the recognition of the role of celebrity and famous people, the critical culture" (p. 324). In Bazerman's example, the genre transformation has occurred through experimentation and changing expectations, but the fundamental form and function of a news story remains consistent.

Yates and Orlikowski (2007) describe a different kind of genre experimentation that results in, what they call, *corollary genres*, "that is, distinct (albeit related) genres that are enacted alongside the original and that may ultimately evolve into completely separate genres (e.g., the memo as it evolved from the letter)" (p. 8). To demonstrate this type of genre innovation, they trace the emergence of PowerPoint presentations as a derivative of

the business presentation genre, which existed in the form of presentations accompanied by visual texts well before the introduction of Microsoft PowerPoint. They articulate certain conventions, or what they call "stabilizing features" of the PowerPoint business presentation as it has been typified in the business community—conventions, like purpose, content, form, participants, space, and time (pp. 12-22). Over time, Yates and Orlikowski argue, the PowerPoint business presentation has also produced corollary genres, like the online slideshow for individual viewing, which removes the presenter all together. The authors add, "until clearer expectations arise around these corollary genres, we can expect continued ambiguity, communicative difficulty, and discursive experimentation" (p. 25). This statement is, at present, reminiscent of the infographic genre as it has been described earlier in this proposal as a corollary to the poster presentation at academic conferences (e.g., *Digital Frontiers*, 2017), and to a traditional, print or online resume (e.g., visualize.me), to name two examples. The consequences of this type of experimentation are not yet clear, but of interest to the present study is whether and in what ways students have interacted with infographics as corollary genres.

Boundary Objects. Likewise, disciplinary boundaries are not static; they, too, change over time with the introduction of new, influential members, experiences, and texts. Wenger (1998) refers to "brokers" of this kind of change as those who transform discursive practices in a community of practice, often mediated by a *boundary object*, or an artifact, document, or organizing concept. One example of this phenomenon is statistician, Hans Rosling, who served as an early adopter of interactive, information visualization in the academic community and a broker of interactive infographic genres in academia. His 2006 TED talk on population has received over 12 million views, and others in scientific fields

have borrowed from his example to communicate scientific information in a dynamic and visual way.

A boundary object is distinct from a corollary genre in that it is brought in and appropriated by a community from another source, like a profession, some aspect of popular culture, or another discipline, for example. Bazerman (2014) adds that this change can be the deliberate act of an established member: "Understanding the form and flow of texts in genre and activity systems can even help you understand how to disrupt or change the systems by the deletion, addition, or modification of a document type" (p. 311). Polman and Hope (2014) have identified infographics as boundary objects in the field of science education, citing Star and Griesemer (1989) to define boundary objects as, "'objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites'" (p. 317). In their case study of science news stories, a student-produced infographic was a boundary object between graphic design and science writing for the public, and a person with experience in graphic design helped broker the student's graphic design skills with the science news genre (p. 332). In the framework of communities of practice, students function as legitimate peripheral participants (Lave & Wenger, 1991), who are enculturated into the practices of a community by participation in it, supported by more experienced members. As such, the present study seeks to consider how and to what extent infographics are regarded as boundary objects between different communities (e.g., disciplines and publics; disciplines and legitimate peripheral participants) in higher education.

Situational Expertise. For this study, the notion of expertise is relative, meaning that a veteran scholar in a community of practice is likely to have developed a certain,

requisite level or type of expertise with certain activities that is greater than someone just entering the field. As genre theorist, Carolyn Miller (1984) explains, much of a person's disciplinary or professional identity is learned by participating in genre systems: "[…] for the student, genres serve as keys to understanding how to participate in the actions of a community" (p. 165). This idea has consequences for the use of texts as corollary genres or boundary objects in disciplines. Referred to previously as a "way of knowing" (Carter, 2007) or procedural knowledge (Anderson, 1995), the condition of knowing *when* and *how* to select and use an infographic text as a boundary object between a discipline and a public or learning audience might require certain disciplinary expertise related to the rhetorical situation. For example, when positioned as an instructor of a class (e.g., as a teaching assistant, instructor of record, etc.), one might need to know how to evaluate texts for suitability as a pedagogical device (e.g., visual accompaniment to a lecture, assigned reading or writing, etc.) that will function as a boundary object between the learners and the content or practices of a discipline.

The same idea applies for the condition of knowing when and how to use texts as corollary genres in a rhetorical situation. An example of this might be knowing when it would be appropriate to present an infographic text at an academic conference or for a class presentation, versus when such a text would break with convention and not be well-received by the intended audience. Within a discipline as a community of practice, graduate students and postdoctoral researchers may not be expert instructors or researchers, but they will have relative expertise to undergraduates in the functions of certain genres for certain conditions or rhetorical situations.

Infographics and Experimentation in Writing Studies

One type of genre experimentation responsible for producing corollary genres and introducing boundary objects with new and digital media, in writing studies, is the notion of *remix* and *remediation* (Bolter & Grusin, 1999). The process, say Bolter and Grusin, is not new:

> A painting by the seventeenth century artist Pieter Saenredam, a photograph by Edward Weston, and a computer system for virtual reality are different in many important ways, but they are all attempts to achieve immediacy by ignoring or denying the presence of the medium and the act of mediation. All of them seek to put the viewer in the same space as the objects viewed (p. 11).

For Bolter and Grusin, remediation is "borrowing," or building on something that exists to develop something new. This happens when one film borrows from an older one and when computer games borrow from cinema to create interactive narrative play experiences (p. 49). New and digital technologies make it possible for information, such as a person's experiences and qualifications for a job, metadata from a large body of research, etc., to be remediated as infographics. In this way, remix and remediation are new ways of conceiving text production.

Another important theoretical concept related to genre experimentation is *multimodality*, where, similar to remediation, different semiotic elements are combined into a new textual expression. Digital media and technology researcher, Carey Jewitt (2012) situates the idea of multimodality within a sociocultural framework that echoes Lave and Wenger's (1991) community of practice theory and Bazerman's (2004) notion of genre as socially constructed:

> Multimodality assumes that resources are socially shaped over time to become meaning making resources that articulate the (social, individual/affective) meanings

> demanded by the requirements of different communities. These organized sets of semiotic resources for meaning making (with) are referred to as modes which realizing communicative work in distinct ways […] In order for something 'to be a mode' there needs to be a shared cultural sense within a community of a set of resources and how these can be organized to realize meaning (Jewitt, 2012, para. 4).

It is the combination of these semiotic codes across communicative modes, such as print, live performance, gestures, speech, media installations, etc., in addition to the social context in which the codes are disseminated and received, that forms the basic idea of multimodality. And, while composition researchers assert that there is no such thing as a monomodal text (Shipka, 2011; Dressman, McCarthy, & Prior, 2012), multimodality is invoked frequently by compositionists in scholarship about genre experimentation, digital composing, and design thinking in writing (e.g., Sheppard, 2009; Wysocki, 2006; Anderson, 2008; Hawisher, Selfe, Moraski, & Pearson, 2004; Sorapure, 2010). In writing studies scholarship where infographics are the subject of discussion, they are treated as a form of experimentation with multimodal composing, where data, image, text, and (sometimes) animation are combined into a single textual artifact.

Such experimentation is encouraged in some areas of writing studies. In Cheryl Ball's (2004) article, "Show, Not Tell: The Value of New Media Scholarship," she distinguishes between two types of scholarship: research *about* new media that takes new media as its subject of inquiry but still makes its argument through the linear move of traditional, alphabetic print; and new media scholarship, which is research that deliberately juxtaposes various semiotic modes in order to contribute new knowledge in new and aesthetically interesting ways. Infographics have emerged in writing studies scholarship, like

Eodice, Geller, and Learner's (2017) *The Meaningful Writing Project*, but, as of yet, are not the genre of choice for compositionists experimenting with new media scholarship, who trend more toward interactive webtexts, like those found in the journal, *Kairos*.

Instead, scholars of writing make use of infographic texts primarily (though not exclusively) for two *pedagogical* purposes: 1) teaching the concept of rhetorical analysis by presenting infographics as an unfamiliar genre or a genre translation, and 2) teaching design thinking in composition to promote and develop digital competencies and a visual literacy of communication and information.

There are several examples in the literature where infographics assignments are used in professional and academic writing classes. Lindblom, Galante, Grabow, and Wilson (2016) explored an infographic assignment for synthesizing multiple informational and literary texts. This is reminiscent of the way infographics are used in the sciences to convey metadata to public audiences because they synthesize multiple sources into a new, visual, and informational text that tells a data story. Rubens (2017), approached the infographics assignment from a different angle—that of a remix, or genre translation assignment. She writes, "My health humanities composition students composed multimodally by transforming their analytical research essay about a health humanities topic into an infographic; the infographic advanced an evidence-based argument but was intended for a lay audience as opposed to an academic reader" (p. 7). Still, others (e.g., Freberg, 2014) use the infographic assignment to teach an unfamiliar genre and to engage students in visually representing research from multiple sources. A popular text among some instructors who use infographics assignments, "Recipe for An Infographic," by Debbie Abilock and Connie Williams (2014), places the process of infographic design within the research process. These

rhetorical analysis and process approaches to infographic instruction are one way infographics are present in recent literature.

Because infographics incorporate visual elements as well as textual ones, some composition instructors view infographics assignments as opportunities to teach design thinking in composition and facilitate opportunities for students to develop digital competencies with computer and Internet applications and software. Daniel-Wariya (2016) cites principles of design from Robin Williams' (2008) *The Non-Designer's Design Book* in his instructional chapter on infographics for students of writing. Likewise, Lamb, Sheffield, and Winet (2016) refer to the infographics writing assignment as a "way in" to teaching visual rhetoric and design theory. Others (e.g., Matrix & Hodson, 2014; Dur, 2014) have cited similar rationales in their approaches to infographics as pedagogical devices in writing instruction.

However, some contend that composing an infographic takes more than rhetorical analysis of existing infographics coupled with principles of design theory. Stones and Gent (2015) used semi-structured interviews with public health professionals who valued the potential of infographics as genres that could communicate health information to a public audience. They concluded that "infographics production demands a wide range of combined skills such as data mining, programming, writing and graphic design […] as such it presents challenges to any organization where workers have particular specialist skills or roles and it requires targeted investment" (p. 4). This is largely reminiscent of Tufte's (1983) critique of graphics circulated in public media. He writes:

> Nearly all those who produce graphics for mass publication are trained exclusively in the fine arts and have had little experience with the analysis of data. Such experience

> is essential for achieving precision and grace in the presence of statistics […] Those who get ahead are those who beautify data, never mind statistical integrity (p. 79).

One implication of this observation is that infographics are not a straightforward genre that anyone can create, despite the way they are treated by the media and by some in education—they require some specific and distinct skill sets. Another implication is that they may not be as straightforward to read and interpret, particularly if they are done poorly or if the reader expectations do not match the textual artifact. The present study intends to investigate this scenario by asking participants what aspects of a sample set of infographics help or hinder their understanding of it, as well as what revisions they would make to these samples.

Identifying Conventions of an Emerging, Multimodal Genre

There is some useful literature contributing to an understanding of a genre of infographics—what Yates and Orlikowski (2007), following Schryer (1993), would term, "stable for now." That is, some in the fields of composition and education recognize features common to infographic texts across the various communicative contexts in which they have been identified and analyzed. This section begins with infographics, specifically, and ends with multimodal composition, more broadly, with the intention that some of these features and domains for analysis offer a point of departure for my own analysis as data was collected and organized for this study.

In order to understand how experts in science, education, and graphic design read and critically appraise science infographics, Polman and Gebre (2016) interviewed 10 people with expertise in one of three areas: science, graphic design, and learning sciences/education. By comparing expert performance among these three domains, the researchers derived five categories of meaning, intended to be instructive for teaching

infographic reading and writing to students of science: 1) purpose/message; 2) audience; 3) organization and design; 3) representation; 4) data; and 5) sources. They concluded that students should receive direct instruction in how to interpret infographics across these five categories as well as how to plan and execute their writing with attention to these five elements.

In a textbook chapter intended for college students who will, themselves, produce infographics in a writing class, Daniel-Wariya (2016) acknowledges that "infographics can vary widely in their overall approach and appearance, [but] they tend to share four common features […] 1) minimal text, 2) maximum information in minimal space, 3) quick readability, and 4) are usually intended for a generalized audience" (p. 2). These features, or traits, offer learners a fairly straightforward point of departure for reading examples and then composing their own infographics.

Bazerman (2014) warns about the consequences of isolating genre features or treating them as common, stand-alone texts. Limiting genres to their easily identifiable features, he says:

- limits us to understanding those aspects of genre we are already aware of"
- "ignores how people may see text in different ways"
- "make[s] it appear that these features of the text are ends in themselves"
- ignores how genres can change over time (Bazerman, 2014, p. 323).

So, while it may be instructive for learners to begin from a point of common features, there is benefit to thinking of infographics in the domain of multimodal composing more broadly.

Compositionist, Madeleine Sorapure (2006; 2010), has described digital, multimodal composing as a "layered" act, with opportunities for rhetorical decision-making at each layer. In her theory of *infovisual literacy*, she draws from Hullman and Diakopolous' (2011) "editorial layers" of visualizations to discuss and illustrate the kinds of decisions afforded by

each layer: data, text, visualization, and interactivity. The bulleted list, below, contains brief examples from her discussion of each layer:

- Data – Where does the data come from; what is omitted?
- Text – How does the text present on the visualization influence interpretation?
- Visualization – How is data represented visually; what message is conveyed?
- Interactivity – What is the audience supposed to do with the visualization?

(Sorapure, http://sorapure.net/infovis/index.html)

Although information visualization is distinct from infographics, these layers—data, text, visualization, and (to some extent) interactivity—are relevant to the genre. Windsor (2016) offers a useful distinction between the narrative located in infographics and interactivity in infovis:

> There is an inherent tension between narrativity and interactivity, and these can be considered end points of an inversely proportional scale. The outcome of the tension is a means of defining the perspective of an interactive—greater degrees of narrativity suggests an author-driven perspective, creating an interactive object that tends toward explaining data, whereas greater degrees of interactivity suggests a user-driven perspective as users explore data, drawing their own conclusions (Windsor, 2016, ii).

Thinking about writing in this way, Sorapure extends the notion of writing to include rhetorical decisions that occur at each layer of composing, likewise noting that each layer of a multimodal text presents opportunities for analysis. This way of composing deemphasizes a linear and verbal-dependent process; instead, favoring iterative forms of writing.

There are several resources for broad applications of multimodal writing projects, in which infographics are often lumped for their digital and visual composition. Kristin Arola, Jennifer Sheppard, and Cheryl Ball (2014), all recognized multimodal composition researchers and instructors, wrote *Writer/Designer: A Guide to Making Multimodal Projects*, a handbook for students that demystifies the writing process complicated by

unfamiliar digital media, applications, and genres. Likewise, Troy Hicks (2013) combines rhetorical analysis techniques, which he calls "[using] lenses," situated in digital composing environments, coupled with mentor (or example/exemplars) texts in an instructional guidebook for teachers. As a final example, though there are many more, to be sure, the National Writing Project's (NWP) Multimodal Assessment Project (MAP) proposes domains of learning afforded by multimodal writing: artifact, context, substance, process management and technique, and habits of mind. Each of these domains are assessable and are put forth by the NWP as sites of learning associated with the composition of a wide range of multimodal texts.

As legitimate peripheral participants in communities of practice (Lave & Wenger, 1991), students are in a state of learning about how to interact with the many texts in their disciplines. What happens, then, when disciplines appropriate public genres, like infographics, as boundary objects between their conceptual knowledge (e.g., Carter, 2007) and student learning about the ways of doing and knowing? Or, what happens when these genres become corollary to existing disciplinary genres, affecting the way students learn procedural disciplinary knowledge (e.g., which of the available genre options in a set will be most appropriate for a rhetorical situation)? This study begins to examine these questions by analyzing the experiences, perceptions, and differences between undergraduate and post/graduate and professional participants as an initial case.

CHAPTER III. RESEARCH METHODS

Introduction

This chapter describes the design used for an inquiry involving concurrent studies of familiarity with and literacy of infographics. The first stage involves a questionnaire study designed to elicit wide participation from undergraduate students in order to obtain exploratory results about their familiarity with and interpretations of infographics, preferences for different types of infographics, and indicators of a literacy of infographics (mediated by novice/expert knowledge of domain, design, or topic). The second stage involves a qualitative case study of the familiarity, interpretations, and infographic literacy of participants with specific areas of academic and professional expertise.

Two primary questions form the basis of this dissertation study. To start, given that infographics are an increasingly visible and utilized genre, the first question is *How familiar are participants with infographics*? Specifically, using a participant sample from UCSB as an exploratory case, this study sought to understand whether participants had seen different infographic representation types, where they encountered various infographics, whether and in what academic classes they had encountered infographics, and what individual features of infographics made them easier or more difficult to understand.

Next, because infographics are treated in news outlets, social, and educational contexts as ubiquitous genres easy to relate to and make sense of, the second question central to this study is whether there is a *literacy of infographics*? As there are many possibilities for defining and assessing literacy in the broad sense, this study built off of previous research in infographics and visualization literacy (Börner, Maltese, Balliet, & Heimlich, 2015; Polman & Gebre, 2015) in order to investigate three, specific aspects of

infographic literacy: 1) textual features *common to a genre* of infographics; 2) interpretations mediated by markers indicative of *domain, design, and/or topic*; and 3) participant experiences and perceptions of the *function* of infographics as *boundary objects* between academic disciplines and public audiences.

Finally, because the two, concurrent studies involve undergraduate as well as graduate and professional participants, a third research question seeks to understand whether and to what extent differences in experiences and perceptions about infographic exist between these two participant groups.

Rationale for Research Design

This study follows an empirical-qualitative design (Broad, 2012; Haswell, 2012; Calfee & Sperling, 2010), which mixes quantitative methods, like surveys or questionnaires, with qualitative ones, like interviews, in order to elicit important distinctions between different participant groups. According to compositionist, Bob Broad (2012), a benefit of such a design is "distinctive and valuable kinds of knowledge [are] created in the *interplay* between the empirical and textual spheres" (Broad, 2012, p. 203). This kind of work brings together variables, such as *learner characteristics* and *academic disciplines,* with interpretive analyses from observations and interviews in order to understand differences in perspectives. Whereas survey work alone might indicate trends in perceptions or experiences among a particular sample (MacNealy, 1995) and interviews alone might provide highly context-dependent profiles of people who interact with multiple modes of composing (see Berry, Hawisher, & Selfe, 2012), this study draws from both techniques to examine relationships among participants' experiences with writing in academic communities of practice, their technology experiences, and their ways of thinking about

reading and evaluating infographics for the purpose of advancing knowledge of multimodal and infographic writing experiences in higher education. One ancillary goal of this study is to contribute scholarship with an empirical-qualitative methodology perspective to recent, descriptive work on multimodal composition in higher education.

Empirical studies of expertise tend to examine what experts know and what strategies they use that novices do not know and/or use (Peskin, 1998, p.237). In such studies, expertise is relative in that an *expert* has special skills and knowledge acquired through experience. In this way, any patterns in interpretation or ways of describing and organizing infographic texts may be examined. In the present study, a participant characterized as a novice may have some experience with certain digital genres, like blog posts or PowerPoint presentations, and certain computer applications, like Photoshop or Prezi. However, infographic literacy, as it is framed in this study, involves some general level of digital or technical skill but also some experience with infographic genres in situated contexts, like disciplines or professions. Therefore, the "novice" in this study likely will be less experienced than the "expert," particularly when it comes to composing in or for specific academic contexts, like disciplinary learning. This is consistent with the qualities of situated expertise discussed in the review of literature and takes the position that novices can acquire expertise over time through situated learning.

The following sections describe the research methods for the questionnaire study and the qualitative interview that comprise this empirical-qualitative methods design.

Questionnaire Study

Objectives and research aims. In this study, I sought to use ideas generated from the literature review to investigate how and to what extent university students have

experienced infographic texts as ubiquitous genres, as pedagogical devices, and as vessels of disciplinary knowledge. Drawing from data visualization literacy studies, which involve assessing a user's ability to read, make meaning, and interpret patterns from visual representations of data, this study was developed to present participants with different types of infographics and to elicit responses about their familiarity, interpretations, preferences, and sense-making.

Research design. As mentioned previously, the objective for this questionnaire study was to survey undergraduate students' experiences, familiarity, preferences, and infographic literacy in order to inform conversations about teaching and learning with infographic texts. To that end, the research design for this study was informed largely by Börner, Maltese, Balliet, and Heimlich's (2015) scholarship on investigating aspects of data visualization literacy, as well as Chi's (2006) expertise research involving a sort-and-label assessment instrument. Börner, et al. (2015) used a visualization framework comprised of four types of analysis (temporal/when, geospatial/where, topical/what, and network layouts/with whom) and four visualization types (charts, graphs, geospatial maps, and network layouts), in their study of visualization literacy. To implement this framework, the researchers presented youth and adult museum visitors with five data visualizations and asked questions related to participants' familiarity with these visualization types. The questions included whether the participants had seen these types of visualizations before, where they tended to encounter these types of visualizations, how they would read the visualizations, what name or label they would attribute to the visualizations, and what types of data or information was most appropriate for presenting in ways similar to the artifacts for the study (p. 3). Following the open-ended questioning, participants were then asked to put

the five artifacts in order from easiest to most difficult to read (p. 5). Because infographics tend to combine multiple visualization types, including text, charts, maps, etc., into a single artifact, the questions from Börner, et al. were adapted and disseminated as an online questionnaire in order to obtain the largest possible participant group for this questionnaire study by one researcher.

Research instrument. Participants were asked to complete a questionnaire containing up to 59 questions, depending on conditional responses, divided into four parts. The quantitative portions of the questionnaire followed Likert-scale survey design guidelines (Vagias, 2006; Likert, 1932). Qualitative portions included short-answer questions that allowed participants to expand on their Likert responses and to support understanding of participants' experiences. Part 1, the Consent Form, was required in order for participants to begin the questionnaire. Demographic information, including age, undergraduate status, and major or home department were collected on the second part of the questionnaire. Following these two sections, participants were presented with four different types of infographics, labeled in the questionnaire as "data presentations" (Börner, et al., 2015), and then were asked three questions to assess familiarity: *How familiar are you with this **TYPE** of data presentation? Where have you encountered information presented like this? What would you call this **TYPE** of data presentation?* (Appendix B).

In Section 3, participants were presented with the term "infographic" and asked a series of Likert-type questions about their experiences with infographics in common contexts, like academic classes, social media, and news. These questions were meant to help identify whether, where, and how participants had encountered infographics in their daily lives.

As aspects of infographic literacy were of interest in this study, this was assessed in three ways: First, as mentioned previously, the term "infographic" was omitted from use in the first part of the questionnaire in order to avoid cognitive bias in the question design for questions that asked students to enter a label for the infographic presented to them. Adapting methods from Börner et al., for this exercise, participants were presented with the same, four infographics from Section 2 again and asked to order them from *easiest to read and comprehend* to *most difficult to read and comprehend*. For the infographics that participants had placed first and last, participants were asked the following open-response question: *Why did you select this data presentation as the [**easiest** or **most difficult**] to read and understand? What elements of this presentation [aid or impacted] your understanding, and what other factors contributed to the rank you gave this item (e.g., knowledge about the topic; seen this presentation before, etc.)?* This question aimed to investigate how participants decode infographics they deem easy or difficult, without asking for a straightforward interpretation in which they might repeat the infographic's title in their responses.

Second, in Section 3, participants were presented with eight different types of infographics, referenced in the questionnaire as "items," and asked to sort them into two groups: infographics and NOT infographics. Of interest was to observe whether participants would consistently organize certain items in one category over another, indicating that those items shared or lacked some traits common to a genre of infographics.

Finally, participants completed three sorting activities designed to isolate particular variables. Chi (2006) used list-group-label activities to assess people's expertise. In this exercise, given a corpus of six infographics, participants are instructed to sort and place

them into one of four boxes based on similarities that might warrant their groupings. Then, in a text field provided, participants typed a label to define or describe each grouping. Participants were presented with the same directions for each sorting activity, but were presented with a different corpus, based on the following qualities: 1) Different topic, different structure, common purpose; 2) Same topic, different structure; 3) Same structure, different topic. These organizing qualities for each corpus were not made known to participants. Following each sorting activity, participants were presented with an open-ended question which asked them to provide general comments about why they sorted and labeled the items as they had.

Constructing the protocol. The research apparatus for this questionnaire study is a questionnaire containing different kinds of questions with different, but deliberate, intended functions, described in detail in the previous section and developed using Dillman, Smyth, and Christian's (2009) guiding principles for survey design. The questionnaire underwent rounds of strategic pilot testing in order to ensure reliability (consistency in how the questions were received by different respondents) and validity (accurate measures of the study objectives). To pilot the research apparatus, I elicited the help of three graduate students with experience and recent academic coursework in survey design. These three graduate students reviewed the draft materials (before they were entered into the survey software) for consistency, appropriateness, and applicability to the inquiry. They were asked to review materials with a critical eye for anything that would be confusing or misleading, and they were asked to comment based on their experiences with survey design and empirical research. All had previous professional and graduate-level experience in survey design, quantitative research methods, and qualitative research methods. Two testers were

seventh-year graduate students in the field of education, and their primary research involved program assessment. One tester, a first-year graduate student, came from the field of sociology and was enrolled in a statistics course during the same quarter he reviewed materials for this study. The feedback from this pilot test was used to revise the questionnaire questions and order in which they appeared.

Constructing the corpus of infographics. In line with the goals of this research, which included understanding participants' familiarity, interpretations, preferences, and sense-making with various types of infographics, initial selection criteria for the infographics used in this questionnaire were specified and are listed in Table 2. Internet searches for "infographic" were conducted on curated infographic web sites (e.g., visual.ly), academic organization web sites (e.g., mla.org), government sites (e.g., census.gov), news sites (e.g., foxnews.com), social media (e.g., reddit), and general image searches (e.g., Google Images) in an attempt to obtain as much breadth as possible in the look and type of images presented to participants. Because infographics have seen a rise in use over the last ten years, infographics selected for the study were limited to those published within that time frame. Web links were recorded on a spreadsheet and labeled for style, design, topic, purpose, and publication date. As infographics are an emerging genre, and one question framing this study is whether there are elements common to a genre of infographics, the questionnaire corpus was not comprehensive in presenting every type and style of infographic to participants. Instead, the corpus was designed to present participants with demonstrative breadth and variety in order to test for patterns in participants' familiarity, preferences, and interpretations of them.

After the initial list of infographic selection criteria was created and the questionnaire protocol underwent rounds of revisions and testing, all of the infographics were scrutinized in more detail, and the protocol was revised to include sorting activities (section 3) containing infographics that met particular contextual criteria: news, social media, education. As a result, a modified list of selection criteria was applied to those infographics that already met the original criteria in order to be selected for the final corpus (see Table 2).

Table 2

Infographic selection criteria

Original list of selection criteria (used in instrument pilot)	Modified list of selection criteria (used in questionnaire study)
1. The infographics are published on the Internet. 2. The infographics are published in English. 3. The infographics are labeled by their author(s) or web site(s) as "infographic." 4. The infographics contribute variation to the overall corpus in style, size, design, topic, purpose, and publication venue. 5. The infographics are published after the year 2008.	1. The infographics are available for download in either .jpeg, .png, .gif, or .pdf formats. 2. The infographics contribute to the sorting activities by meeting one of the following context criteria: a. News b. Social media c. Education

Table 3 displays the infographics used for Part 2 of the Questionnaire study, which asked detailed questions about participants' familiarity with "information presented this way."

Table 3

Infographics used for questionnaire study, Part 2

Published Title	Brief Description	URL	Short Title
Tracking how many key positions Trump has filled so far	Number of presidential appointments in various stages of nomination since taking presidential office, compared with 4 previous presidents	https://www.washingtonpost.com/graphics/politics/trump-administration-appointee-tracker/database/?utm_term=.704a5a7bb724	Tracking Trump's Nominations
Virus Trading Card: Dengue Virus	Diagram and features of dengue virus	http://tabletopwhale.com/page7/	Dengue Virus
Globalization by the Numbers: Incarceration Rates	Comparison of incarceration rates in 15 countries	http://www.wwnorton.com/college/soc/essoc5/animations/incarceration/	Globalization by the Numbers
How Quitting Smoking Changes Your Body: Effects of Quitting Smoking	Timeline and color-coded diagram of health effects from smoking cessation from 20 minutes to 15 years	https://visual.ly/m/design-portfolio/effects-of-quitting-smoking-cvs/	Quitting Smoking

Research instrument usability test. Because this study involved adapting some previous fact-to-face interview work (e.g., Börner, Maltese, Balliet, and Heimlich, 2015; Chi, 2006) into an online questionnaire, the research apparatus underwent a second round of piloting for usability. That is, I entered the questionnaire questions and the sorting activity materials into the Qualtrics survey software. In this round of testing, four graduate students (one each in Communication, Art, Sociology, and Education) took the questionnaire as though they were participants, but were asked to provide specific usability feedback about the experience (Appendix C). This feedback was important because I learned about some of the limitations of the Qualtrics survey software and was able to make changes in the way participants navigate the questionnaire (e.g., changes in buttons, numbers of questions per page, etc.), understand what they are being asked to do (e.g., some feedback included explanatory statements on each, new page), and interact with the content (e.g., some images were too large/small). After more rounds of revision, two more graduate students, both from

Education, conducted another usability test but were asked to give only overall feedback (not answers to specific usability test questions asked of the previous participants) and to time their participation. The revised instrument was then prepared and saved as a new project in Qualtrics in order to be employed for a 2-week field test of the study without any previous user data from the usability tests.

Data gathering. Participants for the questionnaire study were recruited by invitation through a Sona Human Subjects pool housed and managed in the Gevirtz Graduate School of Education. Upon enrolling in one of four courses [CNCSP 101, 102, 114, or ED 126], undergraduate students were eligible to participate in approved online studies in exchange for 0.5 units of course extra credit compensation for every 30 minutes of participation. Students registered with the SONA system logged in to see a landing page with the title, availability, and compensation credits offered for all available studies. They would select and register for a time slot for the studies in which they decided to participate, and the number of available studies changed throughout the academic term as researchers added or closed their studies.

The present study received participation between 31 January 2018 and 30 April 2018. Responses were housed in the secure, online Qualtrics database and the compensation process was automated through an integration between the Qualtrics survey software and the Sona Human Subjects pool. Because there were other available studies offered concurrently with this one, it is not known what drove participation as participants self-selected from the many options available to them.

All students enrolled in one of the four subject-pool-affiliated courses and registered in the SONA database were eligible to participate. A total of 86 completed questionnaires

were returned to the researcher, but the response rate is not known because participants self-selected and were not otherwise recruited by invitation. Six of these questionnaires had 85% or more missing or incomplete data on the items relevant to this study; so those cases were removed, and the remaining 80 completed questionnaires were used for analysis (*N*=80). Of those 80 participants, 69 were female and 11 were male. This gender distribution is reflective of the gender distribution norms, which skew toward female, for this particular Sona Human Subjects Pool (M. Boyer, personal communication, October 30, 2018). All of the participants were undergraduates in with either junior (29%) or senior (71%) status toward their degrees. Although participation did vary among students with different academic majors, it is notable that 52% of participants were declared psychology majors and 22% of participants were declared sociology majors. As the course of study one takes for an academic major may influence a person's experiences with particular genres, this distribution may be a limitation of the questionnaire results for this exploratory case study.

Qualitative Interview Study

Objectives and research aims. A primary question under investigation in this study is whether there is a *literacy of infographics*. Rather than implement a standardized assessment of an individual's skill at reading and interpreting infographics, in which case there would be "correct" and "incorrect" responses, this study set out to empirically answer three main questions about infographic literacy: a) How and to what extent do readers identify certain features of infographic texts as *common to a genre of infographics*?; b) How are infographics mediated by novice/expert knowledge of domain design, and/or topic?; c) How and to what extent do readers identify infographic texts as *boundary objects between disciplines and a public audience*? Accordingly, the goal of this second, qualitative study

was to understand how and to what extent participants with relative disciplinary and/or professional expertise had experienced infographic genres, as well as their preferences, interpretations, and the aspects of infographic literacy described above. To do this, qualitative interview data was collected from seven participants and analyzed for "telling cases" (Mitchell, 1984), rather than for broadly generalizable results.

Research design. Drawing from related scholarship on infographics as genres that communicate scientific knowledge with implications for their use in science education contexts, the present study aimed to investigate whether and to what extent participants from other disciplinary traditions had similar experiences and would similarly appraise the infographics presented to them in an interview. Polman and Gebre (2015) designed an empirical study of experts' critical appraisal of science infographics in an effort to develop educational curricula for teaching learners how to communicate scientific knowledge effectively through infographics. In their study, ten participants with expertise in science, graphic design, and/or learning sciences participated in an interview in which they were presented with two science-related infographics and then asked to express their understanding, critically appraise the infographics for what was done well, and suggest modifications to improve the infographics (p. 876). This design largely informed the present study, which adapted these methods to address specific aspects of infographic literacy, including genre recognition, analysis, and appraisal.

Research instrument. For this empirical-qualitative study, participants were invited to complete a semi-structured (Spradley, 1979), discourse-based interview (Prior & Shipka, 2003). In a semi-structured interview, the interviewer prepares an open-ended question set to be answered by the participant. With the overarching research aims in mind, the researcher

may ask follow-up questions or use informal prompting that are not present on the list of prepared questions in order to keep the participant talking. Doing this deviates from the standard protocol that is designed for consistent interviewing across several participants in a study but is intended to elicit better depth of response to the inquiry (Spradley, 1979).

In a discourse-based interview, participants complete a task or are presented with an artifact and then asked questions about the task or artifact. Prior and Shipka (2003) applied this method to a study of twenty-one academic writers' multimodal composing processes. In this study, participants were asked to complete two visual representations—one of the composing space and another of the composing process—which were followed up with a discourse-based interview about those visual representations. For the present study, adapted from Polman and Gebre (2015), participants were presented with five infographics originally published on the Internet and asked to select one of interest to center our discussion. The questions presented during the interview were all designed to elicit responses about participants' experiences, preferences, and sense-making around the particular artifact they had selected from the corpus.

Constructing the protocol. The original design of this study occurred concurrently with the design of the questionnaire study, so the selection criteria for the corpus of infographics to be utilized for interviews were the same for both studies (see Table 4). As the protocol was drafted, reviewed, and revised, the corpus of infographics was revised to meet three, additional criteria, including the ability to print the infographics legibly on a single sheet of high quality photo paper and relevance of the topics or visualization types to the general academic disciplines of the interview participants. The latter criterion was determined by conducting an exploratory analysis of the content areas from which

participants in the questionnaire study indicated they had encountered infographics for academic purposes. Though it was left to the interview study participants to decide which infographic they would like to examine further, the corpus was designed to include common graphical forms, like timelines, or general topics of interest, like gender or finance.

Table 4

Infographic selection criteria

Original list of selection criteria (used in instrument pilot)	Modified list of selection criteria (used in interview study)
1. The infographics are published on the Internet. 2. The infographics are published in English. 3. The infographics are labeled by their author(s) or web site(s) as "infographic." 4. The infographics contribute variation to the overall corpus in style, size, design, topic, purpose, and publication venue. 5. The infographics are published after the year 2008.	1. The infographics are available for download in either .jpeg, .png, .gif, or .pdf formats. 2. The infographics include topics or visualization types relevant to the general academic disciplines of interview participants. 3. The infographics can be printed legibly on 8 ½ x 11-inch high quality photo paper.

Five infographics were selected from e-textbooks, online news, and curated infographics web sites (e.g., *visual.ly*) for use in the final research protocol for the interview study. All of the infographics combined graphic visualization types with qualitative information or processes, and all of them were available online for download. One of them was selected from a curated infographics web site, *visual.ly*, two of them came from educational or community activism web sites, one came from the public portfolio of an individual's published work, and one came from an online magazine, *good.is*, with a designated "infographic" section. Table 5 lists the five infographics selected for this corpus. All but the final infographic were selected by participants for use in the interviews.

Table 5

Infographics used for interview study

Published Title	Brief Description	URL	Short Title
A Brief History of Computer Science	Timeline of Computer Science people and innovations between 2300 B.C. and 2012	https://visual.ly/community/infographic/computers/brief-history-computer-science	History of CS
The Genderbread Person v3.3	Elements of gender and their spectra	http://itspronouncedmetrosexual.com/2015/03/the-genderbread-person-v3/	Genderbread Person
An animated chart of 42 North American butterflies	Field guide chart of 42 butterfly species illustrations	http://tabletopwhale.com/2014/08/27/42-butterflies-of-north-america.html	Butterflies
Transparency: The Largest Bankruptcies in History	Timeline and comparison of large companies that filed for bankruptcy between 1987-2009	https://www.good.is/infographics/transparency-the-largest-bankruptcies-in-history#open	Bankruptcies
Who Shot Ya? How Emergency Departments Can Collect Reliable Policing Shooting Data	Research study of attitudinal, logistical, ethical, and legal factors related to the collection of police shooting data from hospital staff	https://www.blackfeminisms.com/wp-content/uploads/2016/09/Richardson-et-al-2016.pdf	Who Shot Ya?

Additionally, during the pilot phase of the questionnaire study, tests for validity revealed that specific, open-ended questions needed to be added to the interview protocol in order to accurately assess aspects of infographic literacy that were found to be limited in the questionnaire responses. Specifically, questions from Börner, Maltese, Balliet, and Heimlich's (2015) study of museum visitors' familiarity with and interpretations of information visualizations were adapted to address the research questions for the present study. Following revision, the final interview included a think-aloud protocol for participants to verbalize their sense-making of an infographic selected from a corpus of five, as well as seven, open-ended questions.

Setting. Face-to-face interviews were scheduled and conducted between February and April 2018 in an office on campus at UC Santa Barbara. During the interviews, a video camera captured the paper printouts of the infographics in order to record the participants' selections from the corpus as well as the audio capture of verbal interactions between the

participant and interviewer. In addition to audio and video recording, the interviewer provided the participants with a copy of the interview questions for reference and took hand-written notes on another copy of the interview questions while the session took place. The interviewer also provided participants with a copy of the "Informed Consent" form and retained a signed copy.

Participants. This qualitative study was designed to elicit responses about the extent to which participants have experienced infographic texts as ubiquitous genres, as pedagogical devices, and as vessels of disciplinary knowledge. To that end, participants were invited through direct personal contact and word-of-mouth to participate in this study, resulting in a convenience sample of seven participants. Criteria for participation included affiliation with UCSB at the time the study occurred, either enrolled as graduate students or employed in a full-time capacity with the university. Participants volunteered for this study and were not paid for their participation.

Because of a paucity of research on infographic literacy and the variable nature of infographics as an emerging genre, this study is meant to serve as an exploratory investigation of particular aspects of infographic literacy, including genre recognition, analysis, and appraisal, as well as personal experiences. Therefore, participation was not restricted to participants at certain points in their degree programs or in specific academic disciplines. However, an exploratory analysis of participation from the concurrent questionnaire study revealed high participation from undergraduate students majoring in psychology (52%; N=80) and sociology (22%). As a result, focused effort was made to recruit at least one person with relative expertise in each of those disciplines.

Affiliation with a particular academic discipline or research tradition was not required for this study, but the researcher aimed to obtain diverse participation from scholars of humanities, sciences, social sciences, and arts, noting that a participant with relative expertise in one academic or professional discipline is not representative of the traditions, values, or positions of that discipline more broadly. Table 6 contains background information about each of the seven participants who volunteered for this interview study. Participation included four males and three females. Three participants were doctoral scholars who had advanced to candidacy in their disciplines and had defended their dissertation proposals; one doctoral student was close to completing his first year of his PhD program. Two participants were in their second year of post-doctoral fellowship work at UCSB, and one participant was employed full time by the university at the time of the study.

Table 6

Profile of participants for interview study

Pseudonym	Academic Concentration	Details
Brad	History	7th year doctoral candidate in History; Specialization in Environmental History & History of Science; TA experience in history and writing
Drew	Sociology	4th year doctoral candidate in Sociology; Focus on environmental and cultural sociology; TA experience in sociology
Courtney	History	7th year doctoral candidate in History; Focus on public policy & welfare
Kyle	Environmental Studies	2nd year post-doctoral fellow in Environmental Studies; Writing a book about persistence of endangered species through 20th century
Jennifer	Art	Full-time university staff and consultant, working with employee training; BA in Art, certificate in graphic design; Experience as professional graphic designer
Catherine	Psychology/Neuroscience	2nd year post-doctoral fellow in Psychological and Brain Sciences

Mumukshu	Religious Studies	1st year doctoral student in Religious Studies; BS in computer science; professional experience in business and computer science

Data gathering. Participants were interviewed individually by a single researcher. The interview began with a verbal, think-aloud procedure (Ericsson & Simon, 1993), in which participants were prompted to verbalize their thinking as they read and made sense of the "data presentation" they had selected from the corpus. Following the think-aloud, participants were presented with a line of questioning adapted from Börner, Maltese, Balliet, and Heimlich's (2015) study of aspects of infographic literacy. Participants were asked to, as best they could, identify the genre of the data presentation and to indicate what features signaled that genre to them. An additional line of questioning was adapted from Polman and Gebre's (2015) study of experts' critical appraisals of infographics, including an evaluation of what was done well and what modifications could be made to improve the infographics before them. Interviews averaged 30 minutes, and the audio recordings for each were transcribed and saved electronically for analysis.

Analytical Framework

This section explains the analytical framework developed to code, interpret, and report data collected for this dissertation. This study applied a mixed, empirical-qualitative approach in order to achieve its two main purposes: 1) to understand people's general familiarity and types of encounters with infographics, and 2) to investigate aspects of a literacy of infographics. An infographic framework and visualization taxonomy was developed to ensure reliable identification of individual units of meaning and to control for possible variations in coding. That infographic framework defined infographics by three dimensions of visual communication: visualization of complex data, design, and story

(Krum, 2014; Polman & Gebre, 2015). This section presents the analytical framework, which includes the coding schemes informed by these concepts.

Three types of analyses construct this framework: descriptive statistics applied to Likert-style (1932) responses on the questionnaire; qualitative coding (Polman & Gebre, 2015, citing Strauss & Corbin, 1990) applied to open-ended, descriptive responses on the questionnaire; and telling cases (Mitchell, 1984) that emerged from qualitative coding of interview transcripts (Marshall & Rossman, 2011). The latter two rounds of analyses were an iterative process, which involved reading and parsing through descriptive responses, categorizing common responses, drafting a representative label for each category, and then re-reading and revising the categories until they became codes. Because there are no move-based analyses of the naming, defining, and rhetorical organization of infographics, related works were used to draft the representative labels that became the coding scheme, including those works that informed the infographic framework for this study (Krum, 2014; Polman & Gebre, 2015; Williams, 2008; Börner, Maltese, Balliet, & Heimlich, 2015; Börner & Polley, 2014; Van Slembrouck, 2012).

Qualitative Analysis of Questionnaire Items

Survey participants wrote six short answers to open-ended questions that were related to each of the three survey sections. These responses to open-ended questions were analyzed inductively using an open-coding strategy to generate representative labels, informed by the infographic framework, for conceptual categories that emerged. Once this coding scheme was developed, a constant comparison method was applied to the open-ended responses in order to ensure consistent coding. This method was used by Polman and Gebre (2015), citing Strauss and Corbin (1990), in their analysis of expert appraisals of

infographics from three perspectives: design, science communication, and cognitive/learning science.

With this constant-comparison method for analyzing qualitative data, each open-ended response was broken into individual units of meaning. During this process, certain themes emerged as possible codes for common ideas represented in the units of meaning. Once a category code was created, all items that fell into that category were grouped together. The remaining items were reviewed, and new category codes were tested. This was an iterative process in which units of meaning and category codes were checked and compared until all open-ended responses had been categorized. Because a single respondent might be more descriptive than another, in some cases, this meant that a single response could account for up to three, individual units of meaning; whereas, another response might account for only one unit of meaning. In other words, analyzing open-ended responses according to singular units of meaning favors those responses which included qualitatively more and intellectually different ideas. It was the case also that some respondents who were verbose in their responses generated only a singular idea or unit of meaning.

Because this coding process was applied to short, open-ended questionnaire responses, rather than structured interviews, there were some differences between the application used in this study and the way it was used by Polman & Gebre (2015). For the present analysis, units were categorized by only one code and then removed from the list. Unlike Polman & Gebre, who were coding descriptive and highly contextualized transcripts of interview data, the open-ended responses in the present study were brief and unambiguous, meaning that they neatly fit into categories that emerged from this coding process. The only items that were questionable, though, were notations about "labels." When

a respondent described a diagram or a chart as having "clear label[s]," this unit was coded as part of the *visual representation* because a label is one of the expected conventions of that particular visualization type. When the respondent described "section headings" or "labels," this was interpreted to mean that the respondent was referring to labeled regions on the infographic canvas, which was then categorized as a *design choice*, rather than a convention of the visualization type. The constant-comparison method was necessary, then, to ensure that units of meaning were categorized appropriately and only once.

Tables 7 and 8 present the coding schemes developed for each of the open-ended, short answer questions presented to participants on the questionnaire. These codes were developed using the open-ended coding and constant-comparison method described above. The dearth of prior empirical-qualitative research of this kind applied to infographics highlights the subjectivity of decisions made during the analytical coding process. For this reason, the coding scheme needed to be detailed, explicit, unambiguous when possible, and derived from the infographic framework for this dissertation, informed by related studies of infographics and information visualization.

Table 7

Coding schemes for short-answer questionnaire responses in Section 2

Open-ended question	Coding scheme used for open-ended questions on the questionnaire	
2.14, 2.19, 2.24, 2.29 What would you call this TYPE of data presentation?	TRACKING TRUMP'S NOMINATIONS Visualization Type Infographic Other datavis genre Function Statistics Data Source Don't Know Unrelated Label	GLOBALIZATION Visualization Type Infographic Other datavis genre Function Topic Related genre Don't know Unrelated Label Not applicable
	DENGUE VIRUS Visualization Type Infographic General datavis genre Animation Topic Related genre Don't know General Label Unrelated Label	QUITTING SMOKING Visualization Type Infographic Related genre Function Other datavis genre Don't know Unrelated Label
2.32-2.35 Why did you select this data presentation as the **easiest** to read and understand? What elements of this presentation aid your understanding, and what other factors contributed to the rank you gave this item?	Familiar Genre Familiar Topic Visual Representation Design Elements (Lack of) Clutter Reading Path	
2.36-2.39 Why did you select this data presentation as the **most difficult** to read and understand? What elements of this presentation impacted your understanding, and what other factors contributed to the rank you gave this item?	"Don't Understand" Unfamiliar Topic Visual Representation Design Elements Clutter Reader Experience	

Note: In the right-hand column, the words in uppercase indicate infographic exhibits presented to participants; the words in lowercase indicate codes.

Table 8

Coding schemes for short-answer questionnaire responses in Section 3

Open-ended Question	Coding scheme used for open-ended questions on the questionnaire
3.2 Define infographics.	Information Data Visual Chart Representation Graphic Reader-Response Topic Purpose Reference to text Design Reference to audience Definition by *what it is not* Don't know
3.4 Have you encountered infographics elsewhere? Please explain.	Campus Internet/Online Other Print/Books Retail Service Offices Specific Rooms TV Media Work

Qualitative Analysis of Interview Transcripts

Seven interviews were conducted for this study. During the interviews, the researcher took hand-written notes on a printed copy of the interview questions. Following each interview, the audio recordings were transcribed and coded using a method similar to that applied to the questionnaire study. An open-coding process was applied to initial readings of the interview transcripts in order to generate conceptual categories for each interview, independent of the others. Then, axial coding was used to organize common responses across the seven interviews and analyze the patterns that emerge (Marshall & Rossman, 2011). This is a more holistic approach to coding than the constant-comparison method, which involves breaking transcribed data into singular units of meaning. With axial

coding, a researcher can leave larger portions of narrative responses in tact to deduce overarching themes. Because of the limited sample size for this interview study, results from this analytical method are reported as "telling cases" (Mitchell, 1984) in service of the research questions they are meant to address. Mitchell (1984) explains the function of telling cases in qualitative research: "What the anthropologist using a case study to support an argument does is to show how general principles deriving from some theoretical orientation manifest themselves in some given set of particular circumstances" (p. 239). For this study, results are drawn from analyzing patterns and recognizing differences in responses from participants, and telling cases are used as representative markers in support of the reported results. The coding schemes for interview responses are displayed in Table 9.

Table 9

Coding schemes for interview responses

Interview Questions	Coding scheme used for interview study
1. State your affiliation with UCSB.	Tone
2. As you read this item, think aloud to express your understanding. a) What impressions do you have as you read? b) What strategies are you using/did you use to make sense of this?	Design elements Visualization type Function Storytelling Boundary object Educational tool
3. What would you call this type of data presentation? a) What features signaled to you that this is [what you called it]?	Corollary genre Discipline reference Public audience Learning audience
4. Where have you seen data presentations like this before?	Other audience Infographic features Context Topic
a. How expert do you consider yourself at reading information presented this way? Why do you think so?	
b. How expert do you consider yourself at making data presentations like this?	
5. What do you think is the purpose of presenting information in this way? Why would someone choose to present information this way versus some other way?	
6. What would you say is the topic of this presentation? How familiar are you with the topic presented in this/these presentations?	

CHAPTER IV. RESULTS

Introduction

The purpose of this study was two-fold: First, as infographics become a ubiquitous genre, reaching even academic contexts in which students are asked to read and create such texts during a course of study, this inquiry was designed to gauge general familiarity with infographic texts. Secondly, aspects of infographic literacy were tested in order to seek an understanding of ways that infographics are mediated by particular types of knowledge. Using the methodology of an empirical-qualitative case study, a questionnaire was used to generate knowledge about the experiences of a range undergraduate students, while a qualitative interview sought a more in-depth investigation into participants' experiences and interpretations of infographic texts. This study was guided by three research questions:

1) How familiar are participants with infographics?
2) Is there a literacy of infographics?
    a. How and to what extent do readers identify certain features of infographic texts common to a genre of infographics?
    b. How are infographics mediated by novice/expert knowledge of: domain; design; topic?
    c. How and to what extent do readers identify infographic texts as boundary objects between disciplines and a public audience?
3) What, if any, differences exist between undergraduate and graduate students in their experiences with infographic texts?

The previous chapters described the research design and analytical frameworks for the questionnaire and interview studies. This chapter will begin with an overview of the results and will follow with a detailed analysis of the data.

Overview of Results

This study sought to generate knowledge about aspects of infographic literacy, including participants' familiarity and encounters with infographics in and outside of the academy. Because this dissertation involves a two-study, empirical-qualitative research design, this section will begin with a broad overview of the results in order to present a big picture of significant findings. Following this broad overview is a detailed analysis of the findings from each study. Three research questions guided this study. Each of the research questions and an overview of relevant findings are listed, below:

Research Question 1: How familiar are people with infographics?

The analysis performed on the open-ended questionnaire data revealed several key themes about peoples' familiarity with infographics. First, the data showed a correlation between participants' responses for where they had seen information presented in a similar fashion and the original published context of four, different infographic artifacts with which they were presented. For example, participants tended to indicate "news" as the type of context in which they typically saw infographics like the artifact that had been published on a news web site.

A majority of undergraduate students (74%; N=80) reported encountering infographics as readings and/or assignments in at least one of their three most recent academic classes. 72% of participants indicated that they always or occasionally encounter infographics in the courses they take (more generally). However, 48% of participants

indicated that the statement, “I am an expert at reading infographics,” was untrue or very untrue of them and 69% of participants indicated that the statement, “I am an expert at creating infographics,” was untrue or very untrue of them. Despite the high exposure of students to infographics in their academic classes, they reported low confidence in their expertise toward reading and/or creating infographics.

In the interview study, participants were presented with a corpus of five “data presentations” and asked to select one on which to focus the interview. All seven participants identified their selected artifact as an “infographic,” when asked, “What would you call this type of data presentation?” Four out of seven participants indicated that they had made infographic texts before, and two participants had used infographics as visual aids to accompany lectures they delivered to undergraduate classes they had previously taught. When asked to self-assess their ability to read and comprehend infographics, all seven participants indicated that well-designed infographics should not require expertise; that they should instead be easily comprehended by a wide audience.

Research Question 2: Is there a literacy of infographics?

The analysis performed on the qualitative interview data and open-ended questionnaire responses revealed themes in support of aspects of a literacy of infographics.

Findings from the interviews and questionnaire responses showed several key features common to a genre of infographics. The four most prevalent themes were complex data, multiple visualization types (e.g., graphs; timelines; icons), a central story or topic, and elements of design (e.g., color; repeated elements; font; size). Participants in both studies also mentioned the functions of particular elements (e.g., to guide the reading path; to

simplify complex information) as well as the function of infographic genres more broadly (e.g., to convey a message to a wide audience; to inform; to tell a story).

Elements of design emerged as a common theme mediating infographics in both the questionnaire and interview studies. Given four infographics in the questionnaire study, participants indicated particular elements of design as factors that greatly contributed to comprehension for infographics ranked "easiest to read and understand," as well as factors that greatly impeded comprehension for infographics ranked "most difficult to read and understand." Likewise, it was elements of design that participants in the interview study attributed to an infographic's readability and affordance as both an instructional device and as a presentation of data. During the think-aloud protocols, participants frequently reacted aloud to particular design elements, like font, organization of information, reading path, color, etc., both favorably and in critique. There was not enough evidence to show that explicit training and knowledge of design mediated participants' readings of infographics, but elements of design did function both to support and impede comprehension in both studies.

Domains of academic and professional expertise were also revealed as mediating factors of infographic literacy during the interview study. One participant, with low self-reported knowledge of the topic of her selected infographic, was able to read and interpret her selected infographic with confidence, crediting her familiarity with graphic design and having created infographics previously. Other participants critiqued their selected infographics, stating that they preferred conventional data visualization techniques (e.g., timelines; bar charts; tables) to the ones composed with design techniques (e.g., metaphors; icons; selective placement/proximity) on the infographic artifacts. Another participant

included in her think-aloud protocol interjections from her academic and professional experiences with aspects related to the topic of her infographic artifact.

While both studies tested for the extent to which infographics were mediated by knowledge of their topics, analysis of the data showed that the topic of an infographic was least influential. On the questionnaire study, *familiar* and *unfamiliar topic* did emerge during the coding process as common themes for responses pertaining to explanations of why participants ranked particular infographics as easiest and most difficult to read and understand. However, familiar topic was the least-referenced reason for ranking an infographic as easiest to read and understand, and unfamiliar topic was next-to-last among reasons for ranking an infographic as most difficult to read and understand. Likewise, for the interview study, some participants selected an infographic from the corpus because of an interest in or familiarity with the topic, but all participants agreed that an effective infographic should be comprehensible to people with little or no familiarity with the topic.

Finally, the findings from both studies revealed ways in which infographics are increasingly used as boundary objects between disciplines and certain types of learning audiences. As stated previously in an overview of results for Research Question 1, a majority of undergraduate participants indicated that they had encountered infographics as readings and/or assignments in at least one of their three most recent academic classes. In this way, it is possible that infographics were assigned as brokers of content knowledge and/or ways of representing disciplinary information to a learning audience. Likewise, the interview study revealed ways that participants viewed infographics as effective pedagogical devices for introducing complex disciplinary concepts to diverse learning audiences. One participant had conducted qualitative research and looked to infographics as genres capable

of communicating elements of her research to interested organizations. Others regarded infographics as corollaries to established genres in their disciplines, such as timelines in history and conference presentations in religious studies.

Research Question 3: What, if any, differences exist between undergraduate and graduate students in their experiences with infographic texts?

Perhaps the most notable finding from both the questionnaire and interview studies is the discrepancy between graduate and post-graduate participants' perceptions of the affordances of infographics as pedagogical devices and undergraduate participants' reported confidence in their abilities to read, comprehend, and/or create infographic texts. Four interview participants indicated that infographics were not a genre typical to their disciplines, and that disciplinary experts would neither present information in that form nor would they wish to receive information in that form, preferring instead more conventional representations of data as tables, charts, timelines, etc. However, most interview participants regarded infographics as having affordances for conveying complicated disciplinary concepts to a wide audience, and two participants had used infographics previously as instructional devices in undergraduate classes they taught. This was consistent with questionnaire results showing that undergraduate participants encountered infographics in their academic classes. Nearly half of the interview participants indicated discomfort with reading infographics and two thirds of interview participants indicated discomfort with creating infographics.

Detailed Analysis

The previous section presented a big picture of key results from this study. However, each research question was tested with multiple questions on the questionnaire and in the

interviews. A detailed analysis of the results for the two, concurrent studies performed for this dissertation is addressed and organized by research question in the section that follows.

Research Question 1: Familiarity with Infographics

It has been established that infographics are an increasingly ubiquitous genre, present not only in consumer media spaces, such as news broadcasts, in magazines and newspapers, on posters and social media, but also emerging in academic contexts as representations of content-area information for people to read and expressions of content-area learning for people to write. One aim of the present research is to explore how familiar participants are with infographics. In the questionnaire study, familiarity was tested in three ways: First, in Part 2 of the questionnaire, participants were presented with four items, with the word "infographics" omitted in order to avoid survey bias. A primary goal of this test was to understand whether participants would recognize some or all of these different items as infographics (or some relevant, related genre) and in what contexts participants had encountered information presented in these different infographic forms.

In Part 3 of the questionnaire, participants were asked direct, Likert-style (1932) questions about their familiarity and encounters with infographics. This part attended to two primary goals: First, Part 3 was designed to elicit information about participants' familiarity and experiences with infographics by name; and, second, to compare their familiarity and experiences with their self-reported expertise at both reading/understanding and creating infographics. Parts 2 and 3 were analyzed for Likert responses using descriptive statistics available in the reporting software of the Qualtrics survey application and are reported in this chapter.

Finally, participants were presented with a corpus of eight, very different "items," all tagged or labeled as infographics in their original contexts outside of this study, and were asked to sort these items into two categories—Infographics and NOT infographics—in order to observe patterns, if any, that emerged related to participants' identification of certain types of infographics over others. The results of each of these tests for familiarity are reported in order in the sections that follow.

Familiarity Test #1: Data Presentations

To test for general familiarity with infographics, the term "infographics" was omitted from Part 2 of the questionnaire, in which participants were presented with four data presentations, each accompanied by three questions: 1) How familiar are you with this TYPE of data presentation? 2) Where have you encountered information presented like this? 3) What would you call this TYPE of data presentation? Table 10 contains descriptions and web site addresses for each of the infographics used for Part 2 of the questionnaire. Aggregate data collected for Part 2 are reported for each type of infographic in the sections that follow. Each section contains a descriptive summary of the infographic presented in the questionnaire, based on the visualization framework presented previously in this dissertation. Following the descriptive summary for each infographic is a report of the results from that section.

Table 10.

Infographics used for questionnaire study, Section 2

Published Title	Brief Description	URL	Short Title
Tracking how many key positions Trump has filled so far	Number of presidential appointments in various stages of nomination since taking presidential office, compared with 4 previous presidents	https://www.washingtonpost.com/graphics/politics/trump-administration-appointee-tracker/database/?utm_term=.704a5a7bb724	Tracking Trump's Nominations
Virus Trading Card: Dengue Virus	Diagram and features of dengue virus	http://tabletopwhale.com/page7/	Dengue Virus
Globalization by the Numbers: Incarceration Rates	Comparison of incarceration rates in 15 countries	http://www.wwnorton.com/college/soc/essoc5/animations/incarceration/	Globalization by the Numbers
How Quitting Smoking Changes Your Body: Effects of Quitting Smoking	Timeline and color-coded diagram of health effects from smoking cessation from 20 minutes to 15 years	https://visual.ly/m/design-portfolio/effects-of-quitting-smoking-cvs/	Quitting Smoking

Data presentation 1: Tracking Trump's Nominations. The first infographic was published in electronic format for an online newspaper, *WashingtonPost.com*, and had also been assigned as a course reading for a political science course on campus. It contained a color-coded list of quantitative information about political appointments in four stages of the appointment process, combined with bar charts with other statistical information comparing these numbers against the previous four United States presidents.

Familiarity with information presented this way was split. 46% of respondents indicated that they were either slightly or not at all familiar, while 51% of respondents indicated that they were either somewhat or moderately familiar with information presented this way. When asked to check boxes to indicate where they had encountered information presented like this, 44% of participants checked "published in online news," 30% checked "shared on social media," and 25% checked "assigned as reading for a class." A follow-up question asked those who had marked "assigned as reading for a class" to specify in which class or classes they had encountered information presented this way. The list included

courses from political science (2 mentions), psychology (16 mentions), sociology (7 mentions), communication (1 mention), math (3 mentions), environmental studies (1 mention), writing (1 mention), education (2 mentions), and history (1 mention).

Table 11 displays the labels offered by participants when presented with the question, *What would you call this TYPE of data presentation?*

Table 11

Participants' names for "Tracking Trump's Nominations" infographic

Definition Code	Example Response(s)	**% of responses** (N=80 participants)
Visualization Type	Histogram; bar chart; bar graph; graphs; charts	55
Infographic	Infographic; infographic representation	10
Other datavis genre	Political news; presidential flow chart; data	8
Function	Data comparison; compare and contrasting; comparative bar graph	5
Statistics	Statistics; statistical analysis; statistical graphs	9
Data Source	Poll; elections data; data for voting polls	5
Don't Know	I don't know; unsure; [no response]	11
Unrelated Label	Fear or ego pandering; [restatement of title]	4
Total Coded Elements		85

This infographic, "Tracking Trump's Nominations," contained multiple visualization elements, including bar charts, statistics displayed in large font, explanatory material formatted with color, proximity to other visualization elements, etc. Table 11 shows that, when asked to label the data presentation, participants overwhelmingly labeled it by its primary and most prominent visualization type—bar graph. While this is not an incorrect label, it fails to take into account the other visualization elements present that deviate from a traditional, stand-alone bar graph presentation, and assumes that the question is asking for a label for the most prominent or familiar element of the larger image. Those who did try to account for multiple visualization types offered other data visualization genres for their

responses (e.g., political news; presidential flow chart). After "I don't know" responses, "Infographic" received the next most frequent label, with 10% of respondents offering this label for the data presentation. The coding process revealed that some participants labeled the infographic by what was happening in it rhetorically, as indicated by the "function" code for responses of "data comparison; compare and contrast," etc.

Data presentation 2: Dengue Virus. The second infographic was an animated .gif rendering of a viral capsid, the protective layer outside of a virus' genetic material (Lutz, 2016). At the center of this infographic, the geometric structure and symmetry of the capsid is indicated by thin, white lines, as the spherical capsid appears to spin on its vertical axis, transitioning from inner genetic material to outer protein shell as it rotates. This information is accompanied by static text, written in the convention of a trading card, which includes brief information about the virus, organized by categories, headings and subheadings, and comma-separated lists.

Familiarity with information presented this way trended toward the negative. 63% of respondents indicated that they were not at all familiar with information presented this way, while 20% indicated that they were only slightly familiar. 13% of respondents indicated that they were somewhat or moderately familiar, and 5% indicated that they were extremely familiar with information presented this way. For those who indicated that they were somewhat, moderately, or extremely familiar, 24% indicated that they had seen this type of data presentation shared on social media, 18% had seen something like this published in the news, and 7% indicated that information like this had been assigned as reading for a class. The list of classes in which participants indicated that they had seen information presented this way included psychology (3 mentions) and biology (3 mentions).

Table 12 displays the labels offered by participants when presented with the question, *What would you call this TYPE of data presentation?*

Table 12

Participants' names for "Dengue Virus" infographic

Definition Code	Example Response(s)	**% of responses** (N=80 participants)
Visualization Type	3d model; virtual 3d model graphic presentation; diagram; 360 representation	26
Infographic	Infographic; informational graphic	3
General datavis genre	Poster; moving digital poster; informational poster	13
Animation	Animation; moving graph; animated graphic	8
Topic	Health virus; virus information; brain virus	11
Related genre	Descriptive information card; trading card	6
Don't know	I don't know; n/a	18
General Label	Informational data; gif; interactive presentation	9
Unrelated Label	Xray; profile of something; image; visual	10
Total coded elements		80

Like the infographic preceding it, this "Dengue Virus" infographic was labeled most frequently by participants' understanding of its primary visualization type (e.g., 3D model), followed by "I don't know" responses. Again, some participants (13%) accounted for the multiple visualization types contained in a single image by labeling it as a related data visualization genre (e.g., poster) and some participants (11%) labeled the item based on its topic (e.g., virus information). Only two people (3%) recognized this item as an infographic by name.

Data presentation 3: Globalization by the Numbers. The third infographic was excerpted from the introductory page of an electronic sociology textbook. It depicts a bubble chart containing labels and data reflecting the incarceration rates for 16 countries. Barbed

wire coils around the web page and the bubble chart, and text at the top of the page offers a brief summary of the information presented in the chart.

Students' familiarity with information presented this way trended toward the negative, but included some positive responses. 57% of respondents indicated that they were not at all or slightly familiar, although 39% of respondents indicated that they were either slightly or moderately familiar with information presented this way. There was a fairly even distribution of responses indicating that participants had encountered information presented this way in assigned course readings (29%), shared on social media (27%), and published in online news (25%). The list of classes in which students indicated they had encountered information presented this way included diverse disciplines: education (2 mentions), sociology (12 mentions), psychology (7 mentions), communication (1 mention), history (1 mention), biopsychology (1 mention), linguistics (1 mention), Chicano Studies (1 mention), feminist studies (1 mention), writing (1 mention), English (1 mention), theater (1 mention), nutrition (1 mention), and geography (2 mentions).

Table 13 displays the labels offered by participants when presented with the question, *What would you call this TYPE of data presentation?*

Table 13.
Participants' names for "Globalization" infographic

Definition Code	Example Response(s)	**% of responses** (N=80 participants)
Visualization Type	Circle chart; circle graph; bubble chart/graph; pie chart; dot chart	21
Infographic	Statistical infographic; info graph; infographic	5
Other datavis genre	Prezi; PowerPoint presentation	6
Function	Comparison chart; compare/contrast incarceration	5
Topic	Population demographics; population data	5
Related genre	Scatter plot; venn diagram; flowchart	14
Don't know	Don't know; not sure; [no response]	28
Unrelated label	Statistical data; stylized information; data	11
Not applicable	Confusing; research article; school to prison pipeline	5
Total coded elements		80

Unlike the previous two infographics, the primary response offered for this "Globalization" infographic was "I don't know," with 28% of respondents offering that answer to the question of what they would call this type of data presentation. Participants reported less familiarity with the previous infographic, "Dengue Virus," with 63% of respondents indicating that they were not at all familiar with information presented this way. However, only 18% of respondents offered an "I don't know" response when asked to label the type of data presentation for that item. Participants were more inclined to offer an "I don't know" response for this "Globalization" infographic than for the one with which they reported less familiarity. 21% of participants labeled this infographic by its primary visualization type (e.g., bubble chart/graph), 14% offered a related, general term (e.g., scatter plot; flow chart), and 6% offered an other data visualization genre (e.g., Prezi).

Data presentation 4: Quitting Smoking. The final infographic was retrieved from a curated infographics web site, *visual.ly*. It was commissioned by the media publication,

Huffington Post, and CVS, a retail pharmacy and drug store. The infographic follows the conventions of a print-style poster, with a title at the top of the page, followed by a subtitle, and then a diagram that occupies 5/6 of the page space. Centered on the page is an anatomical graphic of the human body and its cardiovascular, musculoskeletal, and pulmonary systems with color-coded locator pins that correspond between the body part and a timeline that encircles the body like a color-coded halo. The timeline is segmented into chunks containing a unit of time (e.g., 8 hours) and brief, descriptive text containing health information related to the topic of the infographic. The bottom of the page lists sources and the CVSHealth sponsor logo.

Students' familiarity with information presented this way trended toward the positive, with 19% of respondents indicating that this presentation was slightly familiar, 57% indicating that this presentation was somewhat or moderately familiar, and 15% indicating extreme familiarity with information presented this way. There was a fairly even distribution of responses indicating that participants had encountered information presented this way in assigned course readings (25%), shared on social media (32%), and published in online news (32%). The list of classes in which students indicated they had encountered information presented this way included disciplines with similar *topics* to that presented in the infographic: psychology (17 mentions), biology (9 mentions), health/nutrition (11 mentions), sociology (2 mentions), ecology (1 mention), history (1 mention), and education (2 mentions).

Table 14 displays the labels offered by participants when presented with the question, *What would you call this TYPE of data presentation?*

Table 14

Participants' names for "Quitting Smoking" infographic

Definition Code	Example Response(s)	**% of responses** (N=80 participants)
Visualization Type	Pie chart; timeline, circle chart	24
Infographic	Infographic	4
Related genre	Health summary poster; informative poster	6
Function	Informative; informative data	11
Other datavis	Flow chart; data chart; progression data chart	21
Don't know	I do not know; no idea	13
Unrelated label	Phases; body statistics visual representation	18
Total coded elements		80

This "Quitting Smoking" infographic combined more visual elements than the preceding three, with a centered diagram, color-coding, timeline, text, and other info-visual elements. Similar to the other infographics in this section, this one received the most responses for visualization type, with 24% of participants labeling this infographic by one of its prominent visualization types (e.g., timeline) and 21% of participants offering a label for another data visualization genre (e.g., flow chart; diagram). 11% of participants labeled the infographic for how it functioned as an informative genre, and only 4% labeled it as an infographic.

Infographic familiarity result when the term "infographic" was omitted. If we consider where each of these four infographics was originally published and compare that against a ranking of the places where students had seen information presented this way before, we find that these two items match. "Tracking Trump's Nominations," a *Washington Post* infographic, was published on their online newspaper web site. "Published in online news" received the highest ranking (44%) among respondents for the question of where they had encountered information presented this way. The second and least familiar infographic, "Dengue Virus," was published as part of an individual's online portfolio, with links to

share on social media platforms. “Shared on social media” received the highest ranking (24%) among participants for the question of where they had encountered information presented this way. “Globalization by the Numbers,” an infographic published in an electronic textbook, yielded a corresponding “Assigned as reading for a class” as the highest-ranked response (29%) to the question of where participants had seen information presented this way. The final and most familiar infographic style, “Quitting Smoking,” was commissioned by a media publisher and a retail company for wide dissemination online and possibly in print. Both the *visual.ly* web site and the media web links contain buttons for sharing the infographic on multiple social media sites. “Shared on social media” and “Published in online news” received equal rankings (32%) for the question of where participants had encountered information presented this way. It seemed to be the case that, regardless of positive or negative trends in familiarity with the style of infographic presented, participants tended to have encountered certain styles of infographics in the same contexts where the questionnaire exhibits had been published.

Labeling data presentations. Infographics are different from traditional data visualizations because they tend to combine multiple visualization techniques and elements of design into a single, cohesive presentation (see Infographic Framework). In other words, a single infographic might contain a bar chart, a map, and a word cloud—three separate types of data visualizations—on one canvas. Also, unlike traditional data visualizations, which might contain text that denotes the title and legend or key to instruct a reader how to read the image, an infographic might use text in different ways and the reading path might be less structured. So, for each of the infographics presented in Part 2, participants were tested for recognition of these items as infographics or some related genre. All four of the

items presented to participants in Part 2 were referenced as *data presentations*. For each exhibit, participants were asked to state what they would call this type of data presentation. Participants gave varied responses that were categorized by common themes that emerged from the data as it was sorted and coded. Table 15 contains a comparison across common categories for each of the data presentations, color coded by the frequency of responses for each category.

Table 15

Comparative summary of common responses in order of correctness/relevance, color-coded darkest to lightest for response rate.

Data Presentations	% of responses for each category					
	Infographic	Visualization type	Other datavis genre	Related genre	Unrelated label	Don't know
Tracking Trump's Nominations	10	55	8	n/a	4	11
Dengue Virus	3	26	13	9	10	18
Globalization	5	21	6	14	11	28
Quitting Smoking	4	24	21	6	18	13

Table 15 shows that participants offered a wide range of responses to the question of what they would call each type of data presentation. The most accurate/correct response would be "infographic," but that was among the lowest response rate for three of the four infographics. Participants tended to label the data presentation by its most prominent visualization type, as indicated for the dark shading in three of the four infographics, while the next most common response was "I don't know." These results show that, even for those infographics with familiarity results that trended toward the positive, participants did have a difficult time naming these items as infographics and an even more difficult time naming them something similar or closely accurate.

Familiarity Test #2: Self-Reported Familiarity with Infographics

The previous section reported results with respect to students' familiarity with different types of infographics that were not introduced or labeled as such. In Section 3 of the questionnaire, participants were presented with Likert-style and open-ended questions about their encounters with infographics, specifically and labeled as such. Because there are many types of infographics and the genre is an emergent one, this section was intended to examine participants' familiarity with different types of infographics as well as what encounters they have had with infographics in various contexts. The following section reports findings related to participants' self-reported familiarity and encounters with infographics of various kinds.

Defining infographics. Question 3.2 was open-ended, and asked participants to define infographics. Responses from 80 participants were broken into individual units of meaning at the word-level and then grouped by variations of the same term (e.g., information, informative, informational), the same intended concept (e.g., pictures, images; data, statistics), the same or similar descriptions (e.g., short/easy, easy to follow, concise), and common rhetorical functions (e.g., explain, teach, demonstrate, present). Once broken into units of meaning, participant definitions contained 268 elements, which were coded according to the groups described above. The items in each group were tallied and are reported in this section, and results are presented in Table 16, in which high values are color-coded in gray.

Table 16

Elements of participant definitions for Infographics

Definition Code	Example Response(s)	% of instances (N=80)
Information	Information; informative; informational	73
Data	Data; statistics; statistical data	30
Visual	Visual; visualization; visualize	38
Chart	Charts; graphs	24
Representation	Representations; presentation; pictures; images	58
Graphic	Graphic; graphics; graphical	20
Reader-Response	Short/easy; organized; easy to follow; pleasing	16
Topic	Research; topic; news; subject; category	16
Purpose	Teach; catch attention; convey; explain; communicate	35
Reference to text	Textual; verbal; animation	6
Design	Design/s; artistic	9
Reference to audience	Audience; reader; people	4
Definition by *what it is not*	Modern age presentation; alternative to paragraphs; unlike generic graphic	5
Don't Know	I don't know; ?	3
Total Coded Elements		268

When asked to define infographics, the most common response tended to incorporate variations on the idea of a visual representation of information. 73% of responses included variations of the term, *information*, and 58% of responses included variations of the term, *representation*. The most common response of this type defined infographics as, "visual representations of information." To that end, 38% of responses included the word, *visual*, which was the third highest-occurring term among participants' definitions. The shortest response stated, "informative images," while the longest response read, "A picture or a series of pictures with words used to convey information in a way that's telling more than just the words on the page, but rather like an art piece. The words give out concrete meaning, but the pictures set the tone, the legibility, among other things." Only two responses stated a variation on the idea of "I don't know."

Participants defined infographics in different ways, but their definitions tended to fall into two main categories: a restatement of the term, *information graphic* or *infographic*, with the same or synonymous terms (e.g., informative; representation, visualization), or an explanation of their rhetorical function. For example, one participant wrote, "Graphics that present data or other information in a pleasing, artistic way," while another wrote, "A combination of visual and textual information used in order to convey/teach a deeper understanding of the topic represented." Although it is possible that some participants ventured a guess at a definition, rather than state, "I don't know," none of the definitions offered were overtly incorrect or unrelated to an accurate definition of infographics constructed in the infographic framework for this study.

Encounters with infographics. Questions 3.3, 3.4, and 3.8 asked participants to share their encounters with infographics in order to get a sense for the frequency of and situations in which participants encounter infographics and to compare against later responses to questions of self-reported expertise at reading and creating infographics.

For question 3.3, participants were presented with three statements about situated encounters with infographics and asked to rate, using a Likert response, the extent to which these statements applied to them. *Figure* 11 displays the results for this question.

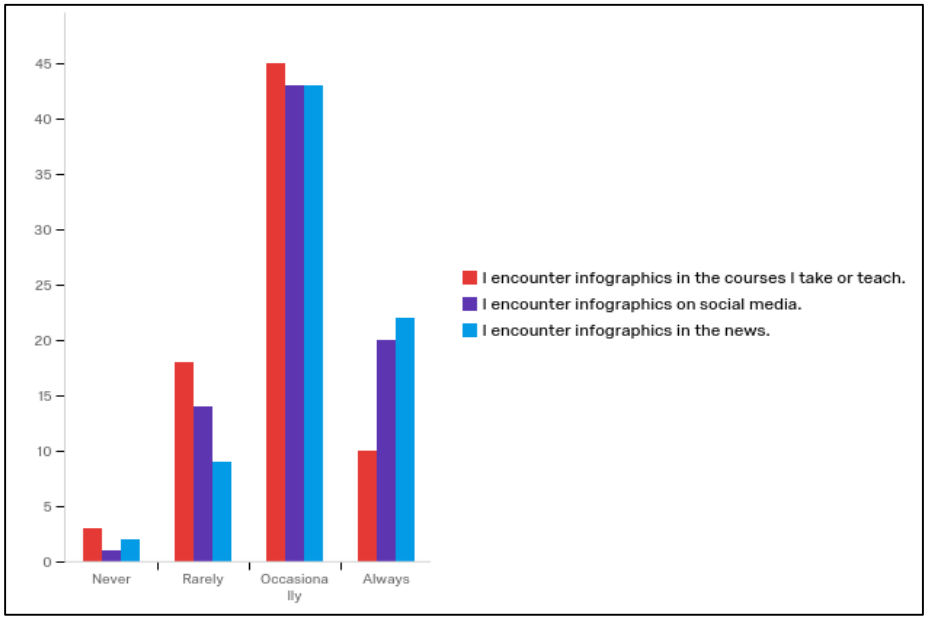

Figure 11. 78 self-reported encounters with infographics in academic classes (red), on social media (purple), and in the news (blue) on a scale of 1 (never) to 4 (always).

Encounters with infographics trended toward the positive, with most responses indicating occasional encounters in all three offered contexts (academic classes, social media, and news). Two people declined to answer this question and were not included in the analysis (N=78). Of the 78 responses offered, 72% of participants indicated that they always or occasionally encounter infographics in the courses they take or teach. 81% of participants indicated that they always or occasionally encounter infographics on social media, and 86% of participants indicated that they always or occasionally encounter infographics in the news.

Question 3.4 was an optional, open-ended, follow-up question, asking participants whether and where else they have encountered infographics. Responses were received from 68 of the 80 questionnaire participants, and were then sorted, categorized, and coded by location. Because the question was worded, "Have you encountered infographics elsewhere? Please explain," some participants answered this optional question with a response of "No"

or "not really." Table 17 lists the results without the 27 responses categorized as No/Not really.

Table 17

Other locations where participants reported encounters with infographics.

Location Code	Example Response(s)	# of instances N=41
Campus	On/around campus; economics courses	8
Internet/Online	Pinterest; mobile games; anime	4
Other	On walls; Greek life; train station	3
Print/Books	Books; readings; posters; textbooks; flyers	22
Retail	Shopping; grocery stores; stores	3
Service Offices	Offices; doctor; doctor's office	9
Specific Rooms	My room; bathrooms	2
TV Media	News; documentaries; advertisements	8
Work	Job applications; creating content for my jobs	2
Total Coded Elements		61

Of the 41 participants who volunteered a response to the question about where else (besides social media, academic classes, and online news) they have encountered infographics, half of them added print media—mainly books, textbooks, and posters—to the list of places they had encountered them. With the exception of Internet/Online, TV media, and Work, additional locations where participants reported encounters with infographics were physical, rather than online, spaces. 4% of added encounters were online or on television, while the remaining 96% of added encounters were in those physical, real-world spaces, mostly in the form of advertisements or educational material.

Encounters with infographics in academic courses. On the questionnaire, question 3.7 asked participants to, as best they could remember, list the last three classes they had taken as a student. Then, question 3.8 asked whether participants had encountered infographics in any one of those three most recent classes. Although this question relies on

participants' memories of previous course work, the aim of this question was to compare recent encounters with infographics in academic courses specifically with the responses to the broader question of whether and to what extent participants encounter infographics in their academic courses more generally (question 3.3). The results for question 3.8, in which participants were instructed to check all that apply, are shown in *Figure 12*.

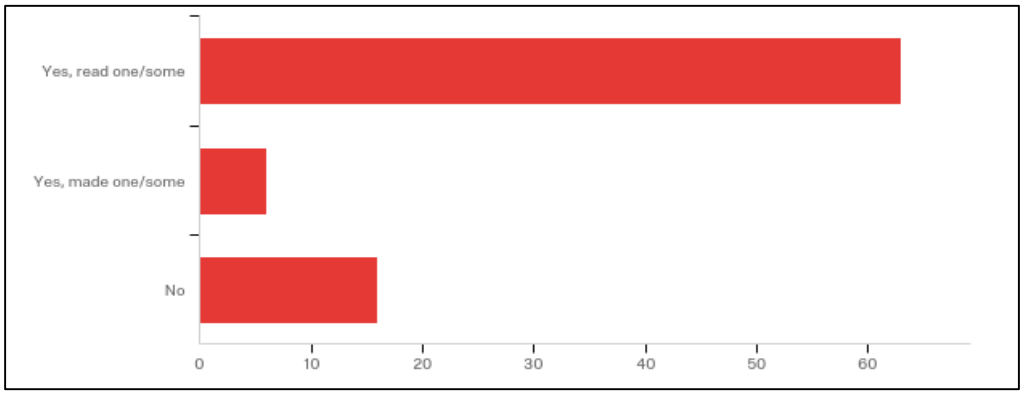

Figure 12. 80 respondents' encounters with infographics as readings and writing in recent academic classes.

Of the 80 participants who responded to this question, 74% of them indicated that they had encountered infographics as readings in at least one of their three most recent classes. This finding is consistent with the results from question 3.3, about the extent to which participants encounter infographics in particular contexts. 72% of the 78 respondents for that more general question indicated that they always or occasionally encounter infographics in the courses they take. Of those 74% who indicated that they had encountered infographics as readings in at least one of their three most recent classes, 6 respondents reported that they had created an infographic for at least one of those classes.

Self-reported expertise with infographics. Another way this study sought to understand participants' familiarity with infographics was to ask them directly to rate their expertise and reading and creating infographics, particularly given their increased use in academic contexts as course readings and writing or presentation assignments. To that end,

question 3.6 presented participants with two expertise statements and asked them to rate, using a Likert response, the extent to which these expertise statements were true of them. *Figure 13* displays the results for this question.

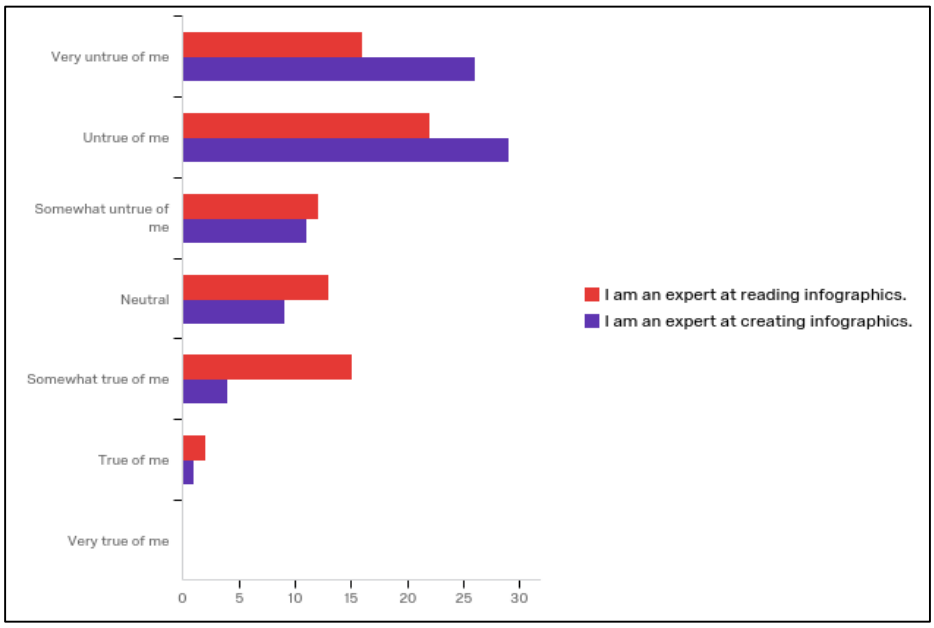

Figure 13. Self-reported expertise at reading (in red) and creating (in purple) infographics for 80 participants on a scale of 1 (very untrue of me) to 7 (very true of me).

Participants indicated that they were generally more comfortable reading infographics than creating them; however, self-reported expertise for reading infographics did trend toward the negative. 48% of participants indicated that the statement, "I am an expert at reading infographics," was untrue or very untrue of them, while 31% of participants marked this statement as somewhat untrue or neutral. Only 2.5% (n=2) of participants indicated that this statement was true of them, and no one indicated that this was very true of them.

Given the statement, "I am an expert at creating infographics," responses trended strongly toward the negative. 69% of participants indicated that this statement was untrue or very untrue of them, while 25% of participants marked this statement as somewhat untrue or

neutral. Only one person indicated this statement to be true and no one indicated that this was very true of them. These findings indicate that, despite the frequency with which students report encountering infographics in their academic classes, those students rate their expertise related to reading infographics as low and for writing/creating infographics even lower.

Familiarity Test #3: Infographic Yes or No Test

The previous sections described two ways that this study tested for participants' familiarity with infographics. First, participants were presented with data presentations and asked a series of questions about them, including whether and where they have encountered information presented this way and what they would call this type of presentation. The second way that familiarity was tested was by asking participants direct, Likert-style questions about their familiarity, types of encounters, and expertise with infographics. In this final test of familiarity, participants were presented with a corpus of eight infographics, called "items," into one of two columns: Infographics or NOT infographics. All of the items were tagged or labeled as "infographics" in the original context from which they were obtained and were selected to represent a wide range of infographic types, from animated

charts, autobiographical representations, and magazine spreads, to student-generated work. *Figure 14* contains the results from Question 3.5.

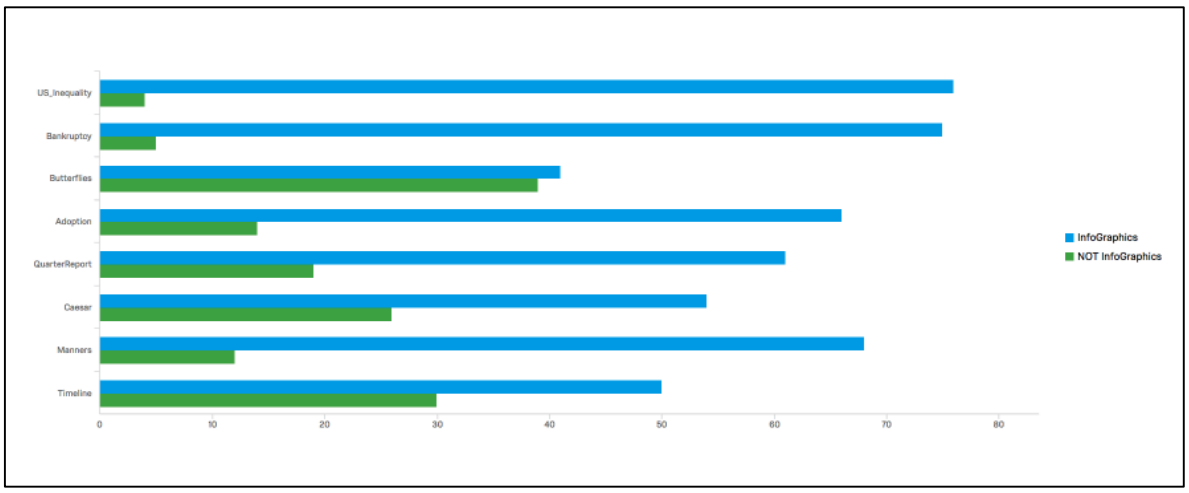

Figure 14. Sorted infographics by 80 participants into two categories: Infographics (blue) or NOT infographics (green).

Participants tended to recognize many of the offered items as infographics, with some exceptions. "Butterflies," an animated infographic composed by the same author of the "Dengue Virus" from Part 2, received a near split in responses, with 51% of respondents sorting it into the Infographics column and 49% sorting it into the NOT infographics column. Another infographic that received conflicted sorting results was "Timeline," a spiraling timeline of prehistoric species and their time period, among other elements. 63% of participants called this an Infographic, while 37% called this NOT an infographic. Two infographics with almost unanimous sorting in the Infographics column were "U.S. Inequality," with 95% of participants calling this an infographic, and "Bankruptcy," with 94% of participants calling this an infographic. These two items were quite different from each other, in that one contained multiple types of charts, graphs, numbers, and stylized facts, while the other told a single story using a single, large-scale metaphor to represent the information in it.

Research Question 2: Aspects of Infographic Literacy

How are infographics mediated by knowledge of domain, design and/or topic? This question was tested in two ways. First, participants in the questionnaire study were asked to sort "data presentations" in order by their ease of understanding, and then to complete narrative, open-ended responses that explained their selections for most and least difficult texts to read and understand. These responses were coded and analyzed using a constant comparison method (Strauss & Corbin, 1990), and are reported in this chapter. Second, qualitative interviews with seven participants involved a focused discussion of one infographic artifact. This section begins with results from the aspects of literacy tested in the questionnaire study and follows with the more in-depth cases revealed through the qualitative interview study.

Aspects of Literacy Tested in the Questionnaire Study

As explained in the introduction to this section, the questionnaire study did not seek to test for infographic literacy in the same way that it tested for familiarity. Although familiarity with infographics is related to a notion of a literacy of them (Börner, Maltese, Balliet, & Heimlich, 2015), the second research question for this study investigated to what extent infographics were mediated by participants' associated domain, design, and/or topic. Domain includes the disciplinary expertise required to read and make sense of an infographic exhibit in the ways of thinking and doing common to members of a particular discipline. Design involves the graphic design elements, like font, size, color, visual metaphor, use of space and proximity, etc. Topic relates to the informational content communicated through the infographic; the "what." Although participants were in their junior or senior year of undergraduate studies, and all of them had declared an academic

major, this study did not treat participants as experts in their academic majors. Therefore, open-ended questionnaire responses were designed to test for the ways in which infographics might be mediated by design and/or topic, but not domain. To that end, analysis of questionnaire results included the entire sample (N=80), rather than results delineated by academic major, which would test for trends in responses by domain. Instead, tests for domain were situated in the qualitative interview study. The following section reports results from the questionnaire study.

Infographics Mediated by Design, and/or Topic: Questionnaire Results

As stated in the Methods chapter, descriptive, open-ended questionnaire responses were coded using a dual-phase process. First, responses were coded using an open strategy wherein responses were analyzed inductively, using the infographic framework, and codes were drafted to represent conceptual categories that emerged. For Part 2, which asked participants to sort and rank infographics by their ease of comprehension and then to explain their reasoning for their highest and lowest ranking, common codes emerged for both the positive responses and the negative ones. That is, codes for factors contributing to comprehension included familiar genre, familiar topic, visual representation, design elements, lack of clutter, and reading path. Complementary codes emerged for factors that impeded comprehension, as indicated by descriptive responses. These codes included unfamiliar topic, straightforward "I don't understand" responses, visual representation, design problems, clutter, and reader experience.

In Part 2 of the questionnaire, participants were presented with four "data presentations," with the term "infographic" omitted, and asked to sort them by how easy

they were to read and understand. *Figure 15* displays the results from this activity.

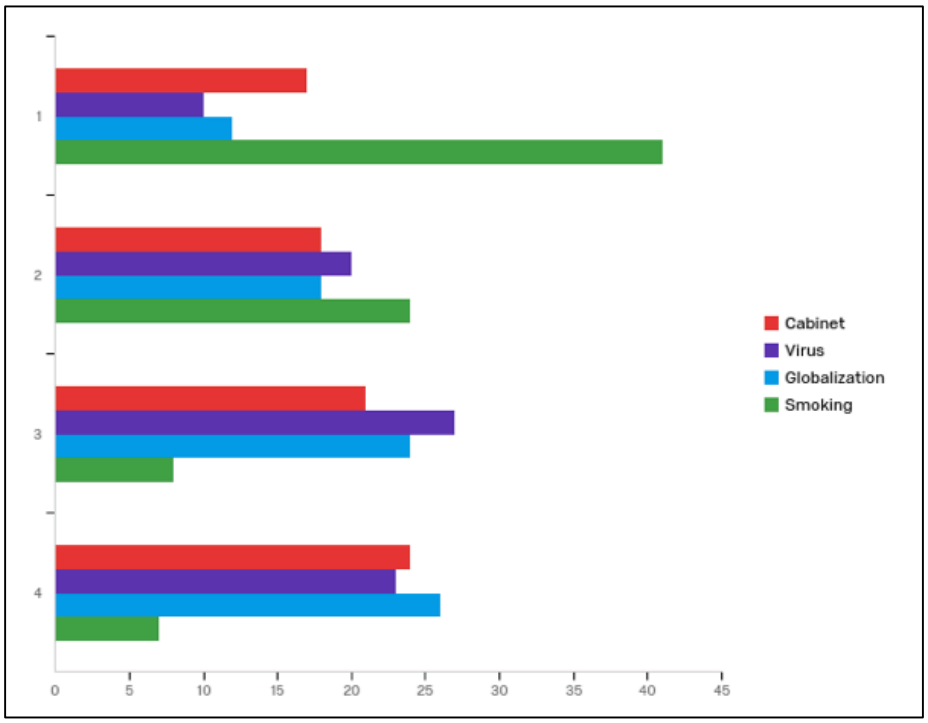

Figure 15. 80 participants' sorting of four infographics--Cabinet (red), Virus (purple), Globalization (blue), and Smoking (green)--from easiest to read/understand (1) to most difficult to read and understand (4).

51% of participants (N=80) indicated that the "Smoking" infographic was the easiest of the four artifacts to read and understand. This infographic was also the least likely to receive a rank of 4, or most difficult to understand. Only 9% of participants ranked it this way, which was the lowest tally of rankings for any of the infographics presented for this question, meaning that most participants found this infographic easiest or close to easiest of the four to read and understand.

The results for those ranked most difficult to read and understand are slightly more mixed. The "Globalization" infographic received the most responses for most difficult to read and understand, with 33% of participants (N=80) assigning a rank of 4 to this item. However, "Tracking Trump's Nominations" (Cabinet) took a close second, with 30% of participants assigning a rank of 4, and "Virus" was not far behind that, with 29% of

respondents assigning a rank of 4. For this reason, it is important to look closely at the narrative explanations of why participants ranked each item as easiest or most difficult to understand.

If we set aside the close distance between those items that received a ranking of 4, or most difficult to read and understand, and we accept that "Globalization" was most often selected as most difficult, an interesting pattern emerges. The results for "Globalization" and "Smoking" appear inversely proportional to each other. *Figure 16* represents this finding, with the data from other two infographics removed to show the inverse trends for these two infographics. That is, most respondents ranked "Smoking" as the easiest to read and understand, while the fewest respondents marked "Globalization" as the easiest to read and understand. Likewise, most respondents ranked "Globalization" as the most difficult to read and understand, while the fewest respondents ranked "Smoking" this way. These trends also raise questions about whether there were particular aspects of these infographics that contributed to their rankings.

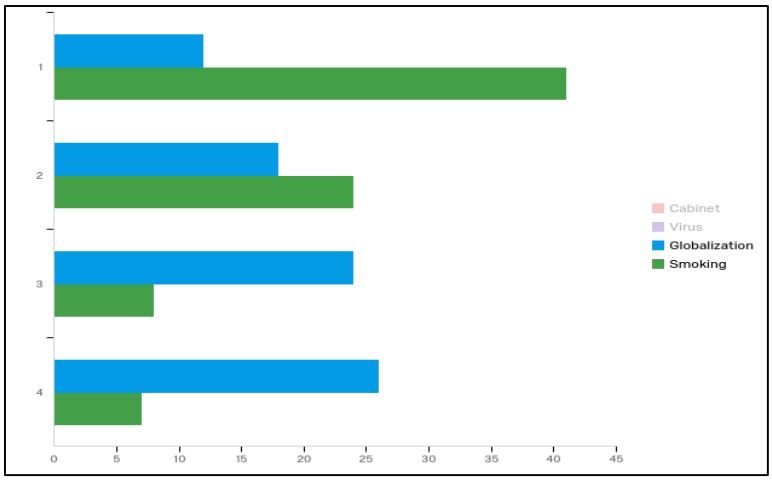

Figure 16. Results for Globalization (blue) and Smoking (green) ranked as easiest to read and understand (1) to most difficult to read and understand (4).

Following the sorting activity, participants were revisited with the images with which they had positioned first (easiest to read and understand) and fourth (most difficult to read and understand). Given those images, participants were asked to explain why they had ranked the item this way, and what elements of the data presentations contributed to their rankings. 80 participants offered responses to this question, and their responses were broken into individual units of meaning and then coded using a constant comparison method (Polman & Gebre, 2015, citing Strauss & Corbin, 1990), such that each of the 150 coded elements were categorized only once.

Table 18 displays the results in raw scores for items ranked easiest to understand (N=80 responses). The right, shaded column contains the sum of responses tallied for each of the six codes. Those six codes include: familiar genre; familiar topic, visual representation; design elements; (lack of) clutter; and reading path. The lightly shaded cells represent the code for which each data presentation received the most responses. That is, the most commonly-stated reason for selecting "Tracking Trump's Nominations" as the easiest to read and understand was visual representation, or some reference to the graphs or charts in the data presentation. The most common trait contributing to a high ranking for "Dengue Virus" was lack of clutter. For "Globalization" and "Smoking" alike, the most common trait contributing to a high ranking was design elements. As the "Smoking" infographic was ranked easiest to read and understand by 51% of the participants, that item also included the highest number of coded elements for each of the six category codes.

Table 18

Participants' stated reasons that this data presentation was easiest to read and understand.

		# of responses for each data presentation				
Code	Example Response(s)	Tracking Trump's Nominations (Cabinet)	Dengue Virus	Globalization	Smoking	Total responses for this code (N=80)
Familiar genre	Have seen many pictures and images like this	4	2	1	9	16
Familiar topic	This is a topic that I am familiar with	2	2	3	8	15
Visual representation	Data laid out well; graph was easy to interpret	11	4	3	18	36
Design elements	Different colors; typeface is simple	7	2	6	35	50
(Lack of) Clutter	Concise language; there isn't too much going on	0	6	1	9	16
Reading path	Organized in a certain order; key points brought to the forefront	3	1	2	11	17
Total coded elements						150

These results suggest that design elements, like "shapes and sizes paired with colors," "typeface is simple," and "big number = key points," for example, were the greatest factor contributing to participants' self-reported understanding of an infographic artifact. Visual representation was the next-greatest factor contributing to participants' understanding of an infographic, with responses like "graph was easier to interpret" and "diagram corresponds with the timeline" submitted in support of this response. Across the four infographic artifacts, familiar topic contributed to participants' understanding, but it was the least-offered response out of the six category codes.

Table 19 displays the results in raw scores for items ranked most difficult to understand (N=80 responses). As with the previous table, the right, shaded column contains

the sum of responses tallied for each of the six codes. Those six codes include: Don't understand; unfamiliar topic, visual representation; design elements; clutter; and reader experience. The lightly shaded cells represent the code for which each data presentation received the most responses. That is, the most commonly-stated reason for selecting "Tracking Trump's Nominations" as the most difficult to read and understand was visual representation, or some reference to the graphs or charts in the data presentation. Visual representation was also the most frequently-stated reason for those participants who ranked "Dengue Virus" as most difficult to read and understand. Clutter was the biggest-stated problem for "Smoking," which received the least amount of negative feedback contributing to a low ranking for this question.

For "Globalization," however, which was the infographic ranked most difficult to read and understand by 33% of participants (N=80), the most significant factor in its ranking was its design elements. 38% (N=55) of coded elements for this infographic alone included references to design problems, such as problems with color (e.g., "the colors are all similar shades, which do not make one stand out more than the other"), graphic design (e.g., "I was distracted by the wires presented around all of the information"), font (e.g., "the information is in very small font"), and use of space/proximity (e.g., "all of the images seem scattered").

Table 19

Participants' stated reasons that this data presentation was most difficult to read and understand.

		# of responses for each data presentation				
Code	Example Response(s)	Tracking Trump's Nominations (Cabinet)	Dengue Virus	Globalization	Smoking	Total responses for this code (N=80)
"Don't Understand"	I have no idea what it's saying; I can't understand it.	3	7	4	1	15
Unfamiliar topic	Little knowledge regarding the topic; least familiar with the topic	12	8	3	0	23
Visual representation	3D image is distracting; bar graph took the longest to read and understand	13	14	9	1	37
Design elements	Small text; too many swirls and convolution; the color	8	8	21	3	40
Clutter	Too many words; messy and too much going on; too much to look at	4	0	6	4	14
Reader experience	The way it is laid out is confusing me; so much information to take in	11	10	12	1	34
Total coded elements						163

Discussion. Part 2 of the questionnaire study tested for some aspects of infographic literacy by examining whether and to what extent infographics were mediated by design and/or topic. As infographics are an emerging genre, with many variations in appearance, purpose, context, design, and topic—amounting to no universally-accepted conventions, for the moment—this portion of the questionnaire study was necessarily limited, with a corpus of four infographics containing different design choices and topics. The results, therefore,

represent a case worthy of further study with a wider corpus of infographics and participant sample.

The results show that design was a significant factor both contributing to and interfering with participants' self-reported ability to read and understand all four of the infographics presented to them in Part 2 of the questionnaire. 33% of all coded elements (n=150) included design features as a factor aiding in participants' comprehension of all four infographics, and design was the *most* significant factor aiding participants' understanding of two infographics: "Globalization" and "Smoking." Design was similarly significant in interfering with participants' understanding of all four of the artifacts, with 25% of all coded elements (n=163) containing some dissatisfaction with the design features present in the infographics. While design was not the most significant factor impeding participants' understanding of more than one individual infographic, it was the most significant factor associated with "Globalization," the infographic that consistently received the lowest ranking of the four for ease of reading and comprehension. These findings suggest design is a significant mediating factor in peoples' reading and understanding of infographic texts.

The findings also show that the topic of an infographic text was less of a mediating factor in participants' self-reported comprehension. That is, when participants were asked to explain why they selected a particular infographic as the easiest of four to read and understand, they seldom identified the topic as a contributing factor. Only 10% of coded elements (n=150) referenced familiarity with the topic as a reason why participants thought an infographic was easy to read. Likewise, 14% of coded elements (n=163) cited the topic as a reason why participants thought an infographic was difficult to read. That said, the terms used to code participant responses were derived using an open-coding strategy, which

means that "familiarity with the topic" was indeed a common enough thread through the responses to warrant its own coding category.

Aspects of Literacy Tested in the Interview Study

The interview study was designed to accomplish one primary goal. It provided a case study for understanding specific aspects of infographic literacy with more depth than the questionnaire, which presented more of a breadth of infographic artifacts to participants. These specific aspects of infographic literacy include the following:

- Research Question 2a: How and to what extent do readers identify certain features of infographic texts as common to a genre of infographics?
- Research Question 2b: How are infographics mediated by novice/expert knowledge of domain, design, and/or topic?
- Research Question 2c: How and to what extent do readers identify infographic texts as boundary objects between disciplines and a public audience?

Seven participants were interviewed for this qualitative case study. Each of the participants was presented with a corpus of five "data presentations" and instructed to select one that they would like to read and discuss further. Table 20 contains a summary of participation information, including the infographic artifact they selected from the corpus for this interview. Participants were invited to select their own pseudonyms. When left up to the researcher, pseudonyms were assigned by the researcher. Transcripts from the interviews were compiled into Microsoft Word documents and the annotation tools (highlighter tool and commenting tool) were used to label conceptual categories that emerged from each interview. The coded data from each transcript was compared with the others, and this round of axial coding (Marshall & Rossman, 2011) was used to identify patterns and areas of

difference across the interviews. The patterns and areas of difference were recorded in a spreadsheet, supported by quotes that represented "telling cases" (Mitchell, 1984) of the findings that emerged. Each of the cases described in the sections that follow exemplify the types of responses received by more than one participant in order to be considered a telling case.

Table 20

Interview Participation Details

Participant ID	Pseudonym	Affiliation with the University	Department	Major Course of Study	Other Background Information (as relevant)	Selected Infographic
AMSOC22818	Adam	4th year doctoral student	sociology	focus on environmental and cultural sociology	TA experience in sociology	Genderbread
BTHIST21518	Brad	7th year doctoral candidate	history	specialization in Environmental history & history of science	TA experience in history and writing	Bankruptcies
CRHIST31418	Courtney	7th year doctoral candidate	history	focus on public policy and welfare		Brief History of Computer Science
CTPSY41218	Catherine	2nd year post-doctoral fellow	psychological and brain sciences	neuropsychology		Genderbread
GMART040518	Jennifer	full-time university staff and consultant	HR & employee training	BA in Art; certificate in graphic design	prior work experience as a graphic designer	Bankruptcies
KBHIST32218	Kyle	2nd year post-doctoral fellow	environmental studies		writing a book about persistence of endangered species through 20th century	Butterflies; Sinking Ships
MVRGST5318	Mumukshu	1st year doctoral student	religious studies	religious studies	BS in computer science; professional experience in business and computer science	Genderbread

Aspects of Infographic Literacy: Interview Results

The results from the interview study are organized in order of the three sub-questions that were tested as aspects of a literacy of infographics and reported as "telling cases" in the sections that follow.

Research Question 2a: How and to what extent do readers identify certain features of infographic texts as common to a genre of infographics?

The themes discovered in the qualitative interview revealed certain features that participants found common to a genre of infographics. In order to avoid inserting researcher bias and threatening validity of the interview data, the infographics printed and used during the interviews were referred to by the researcher as "data presentations" (Börner, Maltese, Balliet, & Heimlich, 2015). First, and notably, all seven interview participants identified their selected data presentation as an infographic. Five of the participants did not offer additional labels for these artifacts, suggesting confidence with their initial label. Two out of the seven participants offered additional labels for their selected data presentations when they struggled with what to call their artifacts. These labels included: public service announcement, data visualization, mind map, and pithy timeline.

The interview protocol included a follow-up prompt, which asked, "What features signaled to you that this is [what you called it]?" Responses were coded at the phrase level, using the infographic framework to categorize the coded elements by one of the following: visualization of complex data, design, and/or story. Results were almost evenly distributed across those three, main categories: visualization of complex data, design, and story. Table 21 displays the results for these responses. When asked what features signaled that they genre they were looking at was an infographic, participants tended to note the visualization

type (e.g., diagram, bar graph, timeline), some reference to elements of design (e.g., color, metaphor, visual images), some reference to how the genre is meant to function (e.g., organized for "obvious" understanding; break down a concept), and even a reference to storytelling or a central idea (e.g., combination of data stories in one image). Participants also referenced an authorial tone (e.g., pithy, poppy, clever, sense of humor). The gray rows in the table represent the three major categories that emerged (visualization of complex data, design, and story).

Table 21

Participants' responses to Question 3a. What features signaled to you that this is an infographic?

Code	Example Response(s)	**Number of responses** (N=7 participants)
	Visualization of Complex Data	
Visualization type	Diagram; use of figure(s); chart; key; more than a bar graph	6
Function	Easily digested; organized for "obvious understanding; breaks down a concept	5
	Design	
Design elements	Pictorial; metaphor; scattered; colorful; elements work together; explanatory "blurb"	11
	Story	
Storytelling	Multiple ways of communicating data into one; combination of data stories; visual information of a story	6
Tone	Sense of humor; light touch; catchy; compelling; clever	8
Total Coded Elements		36

Nearly every participant began their response to the follow-up question with a reference to the way that data was visualized or the function of visualized data for succinctly representing complex information. One participant immediately referenced the visual way that data was represented, as "using this diagram, this little man or person, and the spectra to

communicate concepts and information." Another participant noted the way that data that might traditionally be represented with multiple visualizations was combined into a single one for her infographic artifact: "Basically, the way it's presented as a chart. [An infographic] usually has some type of measurement as far as years are concerned or perhaps percentages, and this one has years as well as information about how much money was lost, too, so that definitely gives it away." One participant referenced the function of the visualization in communicating a larger concept as a feature of an infographic: "[This "Genderbread" infographic has] got some clever…using gender bread and the figure is cute and it's clear that the figure on the left is clear in how they're breaking down gender. Then it gets pretty complicated, but I guess if you're taking a look, just a first look, you get a sense of there are two sides even though they're talking about things that aren't binary. That there are aspects to each of these things and they're separate things." The way that data was represented visually and the purpose for visualizing data that way were early clues to participants that they were looking at an infographic.

All seven participants referenced features of design, like use of color, icons, and metaphors, etc., that signaled a genre of infographics. One participant called his artifact an infographic "because it is so pictorial," while another noted, "this is catchy in that it's colorful." The proximity and reading path of the information was another design reference called out by one participant, who said, "the way it's arranged makes you think of it more as an infographic because even though there is the line going through it, it still feels kind of scattered when you look at it." One participant ("Bankruptcies" infographic) focused on the "stylized" representation of information: "It's like highly stylized with…you know, graphic artists designed all these boats various sizes for some reason […] It's basically a very

familiar bar graph you could represent very simply, but instead they've chosen to use [boats]." This idea—that authorial design choices were made about how the data *could be* represented—emerged consistently across interviews.

Some referenced these design elements as indicators of the infographic genre by contrast to ways that the same information might be represented in a more traditional genre. For example, one participant distinguished the kinds of artifacts anyone can make with an infographic generator, like Canva, as infographics; whereas, artifacts that require graphic design skills and knowledge constitute data visualizations, as is revealed in the following exchange:

> Interviewer: You were referring to the work you were doing in Canva as infographics, and then you're calling this [interview artifact] and your other projects data visualizations.
>
> Participant: I would call those infographics, too.
>
> Interviewer: Why?
>
> Participant: Maybe it's different. The infographic I think of as more with the stock stick figures, and the types of things that show up everywhere and everyone is using those programs to make stuff; whereas, this [interview artifact: "History of Computer Science"] was a graphic designer I imagine, or someone who knows how to use the different programs like Acrobat or Illustrator, which I don't know how to do. So, I guess I think of infographics as more poppy than data visualizations.

Another important design component was the idea that infographics combine multiple types of information into a single, coherent artifact and the idea of quick information consumption. One participant's observation is representative of similar ideas

noted by other interview participants: "[Infographics are] like a set of different kinds of visualizations. But it also seems very important as a way to convey a lot of information quickly in a format that a lot of people can understand."

The story category emerged from multiple, direct references to data stories or centralized stories, as well as a sense of authorial tone or personality present in the infographics. One participant referenced the diagram in his artifact as a "joke;" which, upon follow-up questioning, he clarified, "It's a pun. Like gender versus ginger, is all I meant. So it's like, it's using this figure that looks like a gingerbread man, gingerbread person, as a pun to getting you to think about gender, I guess." One participant made multiple references to the idea of "story" in his analysis of his interview artifact:

> Participant: It's visual information of a problem, or part of a story, I guess […] I guess I often think of the infographic as being related to news, or something like that. This tells a story. Hey, General Motors just went bankrupt. This is why this information is relevant. You have an organizing principle for why you're looking at these boats. There's a little more storytelling, I think, which is why I would call it an infographic.

The ability of the infographic to convey a serious story with a particular authorial tone was another feature common to infographics in this interview, with one participant noting, "[…] the sense of humor that it has. I feel like there's a light touch that I tend to associate with infographics, also, that [this artifact] kind of has." Participants located the idea of story in both their interview artifacts and the genre of infographics, more broadly, as this idea was one of the features that signaled the genre to them.

Research Question 2b: How are infographics mediated by novice/expert knowledge of domain, design, and/or topic?

To answer Research Question 2b, the qualitative data generated from participants' think-aloud protocols, as well as their critical appraisals of the infographic artifacts were analyzed. Responses were coded at the phrase level, and then labeled and organized for domain (major academic area of study or professional work), design (based on the infographic framework), and topic (central idea of the infographic artifact). This study found some evidence that knowledge of domain, design, and topic were mediating factors during participants' interactions with their selected infographics.

Domain. Even though participants were not prompted beyond being asked to state their affiliation with UCSB, the data showed that major domain of academic study did mediate participants' reading of the infographic texts. Mediation by domain occurred for some participants in the selection of infographics from the corpus of texts; and for some, it occurred in their reactions—their questions and interjections—during the think-aloud protocol they completed. Yet, for others, this way of thinking occurred when asked what modifications they might make to their selected infographic; that is, some participants wanted to see data presented in ways that were traditional to their disciplines.

One participant selected his infographic artifact because, with the exception of appearing in a digital, animated format, other aspects of the genre were familiar to the type of work he does as a postdoctoral scholar in environmental studies. He explained:

> [This "Butterflies" infographic] feels familiar. Especially with the range map. That feels like, oh, this is how I would expect—this is in some ways a classic natural history kind of presentation of what a butterfly is. Name, Latin name, map, size,

> shape—yeah. I feel like I've seen it before, I guess something like this in a field guide. Yeah. […] I guess that's like kind of part of our jobs, or my job, anyways. Kind of deconstructing different kinds of information, and figuring out what's there, and how it might be used. I feel like this is familiar to me, or at least this kind of thing. I think if I had a particular question, like what is the range or whatever, of the checkered spot butterfly, or whatever, I could be able to find the information quickly.

In other words, the infographic selected by the participant with domain expertise in environmental studies, contained genre elements familiar to the types of genres he encounters in his domain, including the ways of thinking about and handling particular types of information. For this reason, he expressed confidence in his ability to read, interpret, and act upon the information housed in the infographic, even if the particular topic was not one in which he considered himself an expert.

While reading parts of her selected ("Genderbread") infographic aloud, one participant continually interjected with questions and reactions about the things she was reading. Although the topic of her infographic was not specific to neuroscience, which was her academic domain, her analysis of her own interjections demonstrates one way this infographic was mediated by domain knowledge:

> I find it's always been a fascination of mine—of, I do think we are products of our brains. This is, as someone who's never had to question my sex or my gender identity [the topic of her infographic], it's an interesting mental exercise of where this would come from in the brain or how does this feel; how is this expressed? I'm not questioning these things. I more just trying to figure out, what is the actual physical substrate of all these different things because all of our cells have a sex and

> who knows if they're all expressing the same sex or—portions or what the hormones were in utero and how they shaped different parts of our brains as one or the other or both. It's incredible how many different ways someone can develop and I just don't know what it feels like, so it's interesting thought questions.

With this think-aloud, this participant reflected on the content of the infographic while revealing some of her ways of thinking from a neuroscience perspective.

In a similar move, one participant made connections between her discipline (history) and the infographic she selected:

> That's the question I have after this ["Timeline" infographic], what's the difference between the discipline of computer science and how integral the technology is to its development, because it seems like there's the ideas of it at the beginning, in these ancient stages before they figure it out, and then it turns to more the mechanics. That's weird, that as a discipline they need these mechanical structures, because in history, we just need a book, or a piece of paper that someone wrote on. But I guess even that changes over time, from objects to documents.

These connections aided her sense-making throughout her think-aloud protocol, and this was a move common among participants during their think-aloud protocols, as well.

While domain knowledge played into participants' selection of infographics for the interview and their confidence in being able to read and make sense of them, it was not uncommon for participants to critique their artifacts, wishing instead to see data in a more traditional form. One participant remarked about the limited way information was conveyed in his infographic: "The point is that these big firms went bankrupt, and you can make all

these inferences about that. I think maybe that's just a stand in for these other metrics that are a little bit messier that historians deal with, the lumpiness and things with that."

Another participant took issue with the direction of a timeline, with which one needs to re-orient oneself in order to understand that it is a timeline at all:

> I guess that time is represented as moving down as opposed to up, but I assume that that was difficult, because the boats themselves are sinking. It would probably seem more useful. I just think that in general we either put when I read a chart I'd say the most recent years is either at the top, or at the right. It was oriented 90 degrees the other way, but the most recent year would be at the right. I think it's a little weird. You just have to orient yourself. I guess it's not a fatal flaw, you just have to be like okay, the oldest year is at the top.

When participants applied the ways of reading similar representations of information in their primary academic disciplines, interesting questions and critiques of their artifacts surfaced.

Design. As participants completed a think-aloud protocol to articulate their sense-making of an infographic, elements of design were common points of observation and reaction. Some participants identified design choices that impacted their reading and understanding of the text. One participant reacted to the large design elements, noting the smaller ones as he read further: "I'm looking at the bigger things at the moment, so I'm trying to like, the first thing that I noticed was the big picture, and that was the reason why I actually chose this things in the first place, 'Oh, this has a nice big picture, so let's start with that.' But then I realized that there are smaller fonts and this."

Some participants were distracted by design elements, supposing aloud what they might do differently. One participant noted, for example, "Also, I'm reading like text, which

is in like really small font and I would definitely not do that if I were to do a presentation of data. I mean, I feel that making people read very small text is not a good thing. Presenting data, I always like big fonts, so I think, partly..."

Design was a mediating factor for participants who considered how or why to represent disciplinary data in infographic form. One participant noted the limitations of the infographic genre for representing qualitative information. She noted:

> Some [infographics] lend themselves more easily to quantification. Like, the one I [made] on the transition in medicine worked really well, but then I tried to do one about war on poverty programs broadly, and those are just hard to find, so it's hard to find numbers to pull out of it. That's one of the things that I find—that, as a humanist-slash-historian—that it's not always easy to quantify what you want to show, which is also maybe why I was drawn to this timeline ["History of Computer Science" interview artifact] because it's not like the same kinds of quantified data, like that ship that has the scale of magnitude to represent different things.

This participant was considering how and whether she could quantify her information, as well as what other visualization types might match her communicative objectives. These types of problems are problems of design—namely, how to organize, visualize, and communicate the central story or important information contained in a complex and/or complicated dataset.

The participant with professional experience in graphic design selected her infographic from the corpus "because [she] liked the design of it overall." She shared, "I really like the choice of font. It jumped out at me as something that was easier to read than the others, primarily because it's somewhat simplified […] I really like the use of the

different icons as well. I think that even though the subject matter doesn't interest me much, I just liked what it looked like overall." As she read the infographic, this participant was able to recognize the data visualization as both a timeline and a bar chart, and she understood the general idea being conveyed by the text. Similar to the historian participant, this participant explained that she would like to represent information in infographic form. Unlike the historian, who needed design knowledge to work with her dataset, this participant expressed reservation about her own ability to work *from* a dataset: "I'd want to make sure that the information that I was actually getting—as far as the raw data—I was interpreting that correctly because I'm not an expert at interpreting data. But, otherwise, as far as designing something like this, […] I can easily recreate something like this myself, but I'd want to make sure that I was reading the data correctly." In this way, the participant with the most design knowledge revealed the apparent need to understand *both* design and data in order to comprehend and create infographics in a truly proficient way.

Topic. The topic of each infographic factored into participants' selection for the interview. For instance, one participant selected a particular infographic from the corpus *because* he was familiar with it and had used it as a visual accompaniment to a lecture he delivered in an Introduction to Sociology class he had taught as part of his academic appointment in the Sociology department. He shared how he came to use it in his class: "I've used [this "Genderbread" infographic] before. And I think first saw it when another TA in the first Soc 1 class that I TA-ed gave a guest lecture in a 500-person lecture and used this. They gave a guest lecture on gender. So, then I wound up using this in my Soc 1 class over the summer when I was teaching a much smaller class."

All seven participants suggested that the topic of any given infographic is *not* a significant factor mediating comprehension. On the contrary, participants contended that a well-designed infographic could be read and understood by nearly anyone. One participant, who rated herself at a 1 out of 5 on her initial familiarity with the topic of her infographic (finance), articulated this point further:

> A lot of times, as long as [infographics are] designed well, it can be something that is more easily interpreted by several different types of cultures, even. Because you can identify something like this [*points to a ship*] and you can know that that's a ship whether or not you can even read the language here, even though it's clearly in English. But if you look at the ships and you can also see that there are figures, and it seems like it's some type of monetary value, you can quite quickly get the overall concept of it, and you don't have to necessarily read all of the language here to know what's going on.

In her view, one of the great affordances of infographics is their perceived ability to communicate concepts without the limitations of a singular language or alphabetic text.

Another participant shared this sentiment, which was consistent with all seven participants, about the way infographics are intended to function as broadly consumable texts without requisite topical or content knowledge:

> I don't feel I need to be an expert to read this kind of information. I mean, I think if information is presented in the manner in which it is presented [here], I think it is to kind of attract people who are not necessarily experts—who are not, you know, sort of…I'm not an expert on, say, gender studies, but I can still understand what you're trying to say because you clearly and lucidly sort of laid it out for me to understand. I

> think if this new information the way the image is presented here was presented on *any* other topic, I think it would make it easier for me to understand the topic than before. So, yeah, I don't think I need to be an expert. I think it would help me become an expert on, say, gender studies just by looking at those images.

Once again, this participant viewed knowledge of an infographic's topic inconsequential to one's ability to read and comprehend the information in it, if done well.

While knowledge of domain, design, and topic emerged categorically in the data, it is not clear *to what extent* infographics were mediated by those aspects of infographic literacy. Domain knowledge came into play in the types of questions and reactions participants articulated during their think-aloud protocols, particularly when they wanted to see information represented in a way more traditional to the genres in their associated academic discipline or profession. Design factored into participants' reading paths and comprehension of the information presented, but more or less knowledge of design *as a practice* did not appear to impact their reading. Finally, while some participants selected an infographic with a familiar or interesting topic, all agreed that the topic was inconsequential to their understanding. The data bears out that these three elements of infographic literacy were enacted during the interview, but it is unclear to what extent each element mediated the readings.

Research Question 2c: How and to what extent do readers identify infographic texts as boundary objects between disciplines and a public audience?

To answer Research Question 2c, a qualitative data analysis was conducted on interview responses related to participants' familiarity and experiences with "data presented this way." In the Theoretical Framework, a boundary object is defined as an artifact,

document, or organizing concept brought in to a community of practice, like an academic discipline, by a "broker" (Wenger, 1998). An example of this is a student-produced infographic, which functions as a boundary object between science content-learning and a public audience. For this interview study, when participants referenced disciplinary applications of infographic texts (e.g., as pedagogical devices), those moments were coded for boundary objects.

Boundary Objects. In one interview, infographics were treated as boundary objects between a discipline and a particular type of public audience. When asked why someone might present information this way, one participant responded, "I think it depends on who they're writing for. I could see something like this in a pop history book. It is published by maybe a pop imprint on a university press, or Basic Books, or something because it's gonna reach a wider audience."

The data revealed more than one instance of infographics used as boundary objects between disciplines and a learning audience. In one instance, the participant recognized and selected one infographic from the corpus of five because he was familiar with it and had used it "as a teaching tool" in an introduction to the discipline lecture. His reasoning for using an infographic as a pedagogical device reveals the affordances he saw present in the ("Genderbread") infographic for bridging a complex concept with a learning audience:

> Okay, I think, especially with teaching gender, that can be a tough thing to teach sometimes in an intro class, because you have a really wide range of familiarity with the students that come into an intro class, because there's a lot of…Gender and trans issues are in the mainstream right now, are in popular discourse. So, a lot of people are going to be familiar with it, and a lot of people are going to have their own, self-

> taught familiarity with a lot of these concepts that doesn't come from any academic setting. They may have even seen things like this on the internet, on Tumblr or something like that.

He added that the infographic functions as a leveling device that might even somehow compensate for or complement the limitations of his own expertise on a particular topic he is required to teach. That is, as a doctoral candidate in his discipline, he is considered to have certain, requisite expertise that also qualifies him to teach undergraduate courses in his discipline. Recognizing, however, the limitations of his expertise and the interdisciplinary nature of the lecture topic (gender), he viewed the infographic as a boundary object between the spectra of expertise within his own discipline:

> So, some people might know more about this stuff than I know about it, because I'm not a gender scholar. I said I'm an environmental sociology scholar. I can teach the intro version, but there are going to be people that are sitting in the class that know way more than the intro version, even though they're in an intro to soc class. And then there are going to be people who the idea of sex and gender being a different thing is just going to make their heads explode.
>
> So, I think having some kind of simplification that gets some of that nuance helps to get everybody a little bit on the same page. Because it's such a foreign idea for some people, simplifying it and giving them a visual for thinking about how gender operates, helps get those people who haven't had the chance or haven't been prompted to think about these things in a different way up to the speed of the other people in the class.

It is worth noting that one participant explained why an infographic would *not* function as a boundary object in his discipline. Simply put, he stated that a historian would not present information in infographic form and would not want to receive disciplinary information presented that way. While looking at the "Bankruptcies" infographic, which combined chronological data and relative size data on a single image, he noted, "I think we [historians] would choose to sort either by scale or chronology. It would be one or the other, and not both like this." When pressed further on this, he considered the way that a potential affordance of infographics is not valued by experts in his discipline. He said:

> I think [infographics] allow you to visualize data that would otherwise be uninteresting to look at or read. I think it goes back to a historian probably doesn't care whether they're interesting. […] One of the things that a historian would notice about this [infographic] is these seem to be in absolute dollars, so it would be difficult to compare what $35 billion in 1987 meant in 2009 dollars. I think it's sort of relative, that size. Also, I guess the size of the firm is important, but historians might be more interested in a different scale, like the human scale--like the human scale, jobs lost, things like that.

Another participant parsed through the occasions for which historians might represent information in infographic form. Reacting to the "Brief History of Computer Science" infographic, her initial response was to reject the artifact as a boundary object in her discipline. She said, "as a historian, I want to see things in chronological order." Later, however, she shared that she was working on academic research projects with abundant geographic and narrative data that she and her co-author were trying to package and share with a "general educated public, like college students, maybe high school students, but we

also want it to be used by community organizations to make a case for why public funding should still exist for them. Like, look at these positive impacts it had in the past, and how can we remind policy makers of that in the present." She recognized some affordances of infographics for "convey[ing] a lot of information quickly in a format that a lot of people can understand." With these comments, this participant distinguished infographics as too far removed from accepted disciplinary genres for participants *within* the discipline, but that they also offered affordances as boundary objects between the discipline and certain public audiences, particularly those with some requisite expertise, interest, or experience with topics in the discipline.

Corollary Genres. The themes that emerged from the qualitative interview data also showed some evidence of infographics identified as corollary to other types of data presentations. In the Theoretical Framework, a corollary genre is defined as an emergent and distinct genre derived from a more established genre. Yates and Orlikowski (2007) offer the example of PowerPoint presentations corollary to an established business presentation genre. For this interview study, when participants compared or contrasted infographics to other established genres, either in form or in function, those moments were coded for corollary genres.

One participant contrasted the way data was presented in his interview artifact to the way he would compose the same data for an audience in his discipline. He said, "I think if I were to arrange this [data] as a historian, I would use maybe bar charts or some kind of table with year and you could either sort chronologically or by size. I guess this ["Bankruptcies" infographic] allows you to do both in interesting ways." In a similar line of thinking, one participant supposed that, being a separate and distinct genre, infographics are an inadequate

corollary to the established genres of her discipline. She noted, “I could see academic folks seeing this and feeling like, ‘ugh, this is dumbing down the information that I’m trying to convey in this really complicated argument that I’m making here.’”

Another participant described his interview artifact as a derivative of the bar graph, which is a more established genre. He said, “It’s beyond a bar graph, which if you flip this on its side, and have the dates at the bottom, it's basically a very familiar bar graph you could represent very simply, but instead they've chosen to use [boats]...maybe to draw the eye to make it a little more compelling in its visual. Yeah, it's communicating it to you through this metaphor as well as through hiding the fact that it's just a bar graph.”

While trying to interpret his infographic, one participant described his artifact in terms of a genre corollary to a traditional presentation—one in which an oral report is accompanied by a visual component—but he wrestled with it:

> So, I'm trying to understand firstly, what is this presentation for? Like who are the audience, or who is the audience? Is it for a class presentation or is it for, say, a part of someone's dissertation or thesis to kind of explain, "Okay, this is what I've done, and like these are my findings, or this is my intervention, theoretical intervention of understanding gender." I'm not too sure what this is used for.

He located this genre within an academic context, but struggled to determine where, exactly, this genre might fit.

Summary

The qualitative interviews provided a case study to examine familiarity and aspects of infographic literacy among participants with academic and professional expertise relative to the undergraduate participants in the questionnaire study. All participants recognized their

selected interview artifacts as infographics with some variation in the degree to which they were confident with that label for their artifact. All participants noted the potential for well-designed infographics to be easily understood by a wide and general audience. While some evidence emerged in support of a literacy of infographics defined, in part, by knowledge of domain, design, and topic, there was not enough evidence to determine to what extent any singular type of knowledge was critical to a participants' interpretation, understanding, or perception of an infographic artifact. Each participant drew from their academic and professional experiences to connect, react, and critique elements of their artifact.

CHAPTER VI. DISCUSSION AND CONCLUSION

Discussion

Introduction

The primary purpose of this study was to understand people's familiarity and types of encounters with infographics, as they are treated as ubiquitous genres that anyone can read or create. The second purpose of this study was to investigate aspects of a literacy of infographics, including features common to this emergent genre, the extent to which infographics are mediated by knowledge of domain, design, and/or topic, and the treatment of infographics as boundary objects between disciplines and public audiences. This chapter concludes the present case study by reviewing the research design, summarizing key findings, discussing implications for future research and practice, and presenting concluding remarks.

Overview of Research Study

The introduction chapter for this dissertation identified ways that infographics are treated as a ubiquitous public genre and are also becoming more widely used for academic purposes. With that in mind, this study aimed to investigate, as a case, what types of experiences participants had with infographics in and out of academic settings, as well as what aspects of a literacy of infographics might be at play when participants were presented with examples of infographic texts. Such questions have pedagogical implications for faculty who assign infographic texts as reading and writing assignments in their classes.

The questionnaire study was comprised of a participant sample of 80 upper division undergraduate students participating in a credit-bearing subject pool, and was designed with an emphasis on breadth of familiarity. The interview study included seven doctoral, post-

doctoral, and professional participants who volunteered to participate. This interview study was designed for participants to examine a single infographic for a discourse-based interview, focusing on depth of experience, knowledge, and perceptions. Together, the questionnaire and interview studies form a case of participants with relative expertise (Peskin, 1998) and experiences with the genre sets and textual activities (Bazerman, 1988; Miller, 1984) in disciplines. Following Lave & Wenger's (1991) notion of movement into community membership through a participatory apprenticeship, as well as Paré, Starke-Meyerring, & McAlpine's (2011) "path" toward membership in disciplinary communities of practice, graduate and postgraduate participants were considered to have relatively greater disciplinary experience and expertise with texts and genre sets than the undergraduate participants, despite their collective familiarity with infographics or other visual texts more broadly. Additionally, these studies comprise a case of questions geared toward breadth of experiences and perceptions from undergraduates and depth of the same from graduate and post-graduate participants.

Data was collected from multiple points of the questionnaire and interview studies in order to address each research question.

To test for familiarity with infographics, the questionnaire study included two sections, which could be compared against each other. In Part 2 of the questionnaire, participants were presented with infographics that were called "data presentations" (Börner, Maltese, Balliet, & Heimlich, 2015) and asked a series of questions about them, including a question asking participants to rank four data presentations in order from *easiest to read and understand* to *most difficult to read and understand*, followed by an explanation of these rankings. In Part 3, the term *infographics* was introduced, and participants were asked direct

questions about their experiences and familiarity with infographics, as well as a question which asked participants to sort a corpus of items into two categories: infographics and NOT infographics. Results from Parts 2 and 3 were compared in order to triangulate results and draw conclusions about participants' familiarity with infographics.

Familiarity was examined in the interview study with two interview questions that asked participants to articulate a genre label for the infographic artifact they had selected and to share and discuss where they had seen data presented in a similar way previously. Follow-up questions invited more depth from respondents. Transcripts of the interviews were coded for holistically, and relevant anecdotes or discussion about familiarity with infographics that occurred outside of the two interview questions about familiarity were included in the analysis for this research question.

To test for aspects of infographic literacy, participants in the questionnaire study were asked direct, Likert-style questions about their experiences and familiarity with infographics, and open-ended questions from narrative explanations of an infographic sorting activity were coded for common themes. These themes were analyzed against an infographic framework in order to draw conclusions about a working literacy of infographics.

Infographic literacy was observed, interpreted, and analyzed more inductively during the interview study, when participants used a think-aloud protocol to articulate their reading and understanding of an infographic artifact. They were also asked to critically evaluate the artifact, describing what features were effective and what modifications they would make to the infographic.

Following a year-long development and pilot period, the two studies were conducted concurrently between January and April 2018.

Summary of Findings and Conclusions

This section aligns the three research questions that guided this study with a summary of the findings and conclusions. The first research question that guided the study was:

1. How familiar are participants with infographics?

To answer Research Question 1, data collected from Parts 2 and 3 of a questionnaire were analyzed with descriptive statistics for reporting Likert-style (1932) responses and qualitative coding (Polman & Gebre, 2015, citing Strauss & Corbin, 1990) applied to open-ended, descriptive responses. The descriptive statistical results show trends in familiarity with infographics in the news, on social media, in print, and in academic classes. Certain infographics were more familiar representations of data to students than were others. "Tracking Trump's Nominations," for example, an infographic about the President's progress toward nominating cabinet members, compared with former presidents at the same time into their presidencies, received split responses for familiarity, with 51% of participants (N=80) indicating that they were either somewhat or moderately familiar with information presented in a similar way. Likewise, nearly half of participants recognized the typical context for this type of data presentation as online news. Even when an infographic artifact received a low familiarity rating, as did the "Dengue Virus," an animated infographic that follows conventions of a trading card, participants still tended to adequately place the artifact correctly in its original context.

Broadly speaking, familiarity with infographics as encounters trended toward the positive in the questionnaire study, while self-reported confidence in reading and creating them trended negatively. When asked to label "data presentations," participants most often labeled the artifact with its primary data visualization type, like bar graph, diagram, or timeline. When asked to define infographics, participants most commonly used the words *information* (73%), *data* (30%), *visual* (38%), *representation* (58%), and some reference to a *purpose* (35%) in their responses. When asked about the contexts in which they encounter infographics, 72% of participants indicated that they always or occasionally encounter infographics in the courses they take or teach, and 74% of participants had encountered infographics in at least one of their three most recent classes. 81% of participants indicated that they always or occasionally encounter infographics on social media, and 86% of participants indicated that they always or occasionally encounter infographics in the news. However, 48% of participants indicated that the statement, "I am an expert at reading infographics," was untrue or very untrue of them, and 69% of participants indicated that this statement about creating infographics was untrue or very untrue of them.

While the interview study examined participants' encounters with infographics more narrowly, familiarity with infographics was determined by participants' responses to semi-structured interview questions about where they have encountered similar presentations of data and what they would call the type of data presentation they saw in their artifact. Interview transcripts were coded and analyzed for familiarity using an open coding process to identify conceptual categories followed by axial coding to organize responses across interviews (Marshall & Rossman, 2011). All seven participants identified their artifact as an infographic by name, four participants indicated that they had experience creating

infographics, and two participants had used infographics as visual supplements to oral lectures in academic settings. All participants agreed that well-designed infographics should be easily comprehended by a wide audience; but one participant, whose selected artifact he had used previously in an instructional context, recognized that there were elements he had not noticed or read before using the infographic as an instructional tool.

The second research question was:

2. Is there a literacy of infographics?

To answer research question 2, an infographic framework was constructed drawing from previous scholarship on information visualization (Börner, Maltese, Balliet, and Heimlich, 2015; Börner and Polly, 2014), design (Williams, 2008), and infographics (Polman and Gebre, 2015; Krum, 2014). Open coding was conducted on both the narrative responses for the questionnaire and the interview transcripts, and the infographic framework was used to help label the conceptual categories that emerged from rounds of coding.

The findings from this study support the notion of a literacy of infographics, determined in part by features common to the genre. Such features included a design aesthetic (e.g., color; proximity of information; metaphor), multiple visualization types (e.g., graphs; icons; lists), and a central topic, story, and/or purpose.

The findings also revealed some evidence in support of a literacy of infographics mediated by knowledge of domain, design, and topic, but more research is needed to test these results. While knowledge of domain was not explicitly tested with direct questions for participants, interview participants made multiple comparisons and statements of contrast about the way similar information is presented in their major academic discipline. Disciplinary ways of evaluating and reacting to data emerged as common themes in the

interview study, with some participants indicating why they would or would not present information in a manner similar to its representation in the interview artifact. Participants in both studies noted the ways in which design elements impeded or supported their comprehension of the content in each infographic, and the participant with a professional career in design referenced her design knowledge as a key factor in her ability to make sense of the unfamiliar data and topic presented in the artifact. While an infographic's topic proved least influential in a participants' confidence and ability to read and comprehend it in either study, familiarity with the topic did repeatedly emerge as a common theme among questionnaire participants' reasoning for ranking infographics in order of ease of understanding, as well as participants' reasons for selecting the artifact they did out of a corpus of five infographics for the discourse-based interview.

The third research question was:

3. What, if any, differences exist between undergraduate and graduate students in their experiences with infographic texts?

This research question was proposed in order to approach the idea of relative expertise (Peskin, 1998) and to determine whether graduate students and post-doctoral professionals would be more or less experienced with or proficient at reading, discussing, and evaluating infographics than undergraduate students. The results from this exploratory study suggest that familiarity with infographics is consistent across both groups, but comprehension and perceptions about infographics draw contrasts between the groups. Whereas questionnaire participants reported low confidence in their reading and comprehension of infographic texts, interview participants unanimously stated that well-designed infographics would be comprehensible despite a reader's lack of knowledge about the topic or data contained

therein. During the think-aloud protocol for the interview study, participants drew from many funds of knowledge to make sense of their infographic artifacts, including particular process and practices for reading quantitative information, responding to the text, and evaluating the content and design. Because the two studies were designed differently, there was not enough data for a direct comparison of results. However, interview participants tended to view infographics as having benefits for instruction in their disciplines, while questionnaire participants showed less confidence in their ability to read and comprehend infographics, and ranked the educational infographic ("Globalization") as the most difficult of four artifacts to read and understand. This difference among participants is notable and suggests implications for curriculum selection and instruction.

Discussion of the Results in Relation to the Literature

Results from the interview study confirmed that many people share the popular view that infographics are a genre that anyone can read and understand. *The Washington Post*'s Information Designer, Wilson Andrews, regards universal readability as a goal for people who create infographics (Thomas, 2011). Part of understanding aspects of a literacy of infographics is determining what elements factor into a reader's ability to read and make sense of the text. Information designer, Francesco Franchi (2012), referred to the cognitive processing of visual content as *infographic thinking*. In the questionnaire study, participants ranked a sample of infographics in order from easiest to read and understand to most difficult, and then they answered open ended questions about their highest and lowest-ranked selections. In both cases, where participants explained their rankings, the easiest and most difficult to read and understand were impacted by design elements, like color, arrangement of information on the page, and adjustments to the underlying type of data

visualization. “Quitting Smoking” (Table 22), an infographic retrieved from visual.ly, an openly curated web site of infographics, and created for CVS pharmaceutical company to speak to a general public, was most commonly ranked as the easiest of the four to read and understand. “Globalization by the Numbers” (Table 22), an infographic housed as front matter in a chapter from an online sociology textbook, was most commonly ranked as the most difficult to read and understand.

One infographic was intended for a general audience and the other was intended to act as educational material for a learning audience. The expectation would be, then, nearly universal readability, but this was not the case. Although there are multiple ways to analyze text complexity, including a contextual analysis of the reader or readers, their literacy needs, and their purpose or occasion for reading, as well as a qualitative analysis of certain dimensions, like vocabulary, cultural or contextual knowledge demands, layers of meaning and explication, etc. (Hirai, 2010; Fountas & Pinnell, 2012), one method employed by Royal and Erdmann (2018) was to conduct a quantitative analysis of 22 infographics. To do this, they extracted the textual content from each infographic and entered it into an online readability test (readabilityformulas.com). Seven readability tests, which included factors like number and length of sentences, number of words, characters, syllables, etc., reported scores for each infographic. Explanations for each of the calculations are available at

http://www.readabilityformulas.com/freetests/six-readabilityformulas.php.

Table. _. Readability tests for infographics used in questionnaire study, Part 2.

Published Title	Brief Description	Short Title	Flesch Reading Ease Score	Gunning fog	Flesch–Kincaid Grade Level	Coleman–Liau index	SMOG index	Automated readability index	Linsear write formula	Overall consensus
Tracking how many key positions Trump has filled so far	Number of presidential appointments, compared with 4 previous presidents	Tracking Trump's Nominations	46.5 difficult to read	11.6	9.4	11	9.2	6.9	6.7	9th grade
Virus Trading Card: Dengue Virus	Diagram and features of dengue virus	Dengue Virus	24.6 very difficult to read	16	16.1	14	13.8	16.5	18.3	college graduate and beyond
Globalization by the Numbers: Incarceration Rates	Comparison of incarceration rates in 15 countries	Globalization by the Numbers	39.6 difficult to read	8.3	10.1	13	8.5	7.6	5.9	8th grade
How Quitting Smoking Changes Your Body: Effects of Quitting Smoking	Timeline and color-coded diagram of health effects from smoking cessation from 20 minutes to 15 years	Quitting Smoking	74.3 fairly easy to read	9.4	6.4	8	6.8	6	7.4	7th grade

This process was replicated exactly for the four artifacts presented to participants in the questionnaire study, the results of which are displayed in Table 22. Although a quantitative analysis is a limited way to evaluate text complexity, particularly for highly visual texts, like infographics, this analysis shows that the infographic selected by participants as easiest to read and comprehend ("Quitting Smoking") was also determined by the quantitative analysis to place at the lowest grade level (7^{th} grade) of the four artifacts, and received a notation of "fairly easy to read." "Dengue Virus," which was the second most-commonly ranked as most difficult to read and comprehend, received a "college graduate and beyond ranking, and a "very difficult to read" notation by the readability tests. However, the readability tests analyzed "Globalization," which received scores for most difficult to read and understand, at an 8^{th} grade difficulty level, suggesting some other factors than syllables and sentences contributed to the difficulty students reported with this artifact.

Although this study centered around a genre of infographics, the results resonate with the findings of one of the studies after which the questionnaire study was modeled. That is, Börner, Maltese, Balliet, & Heimlich (2015) tested museum visitors' familiarity with different types of data visualizations by presenting them with five presentations and asking subsequent questions about them. Their results confirmed a low level of data visualization literacy among general audiences, like those who visit museums, and suggested, "that most US citizens cannot read the visualizations that are common in newspapers, textbooks, or on the web" (p. 13). This finding is represented in this dissertation research. In the questionnaire study, undergraduate participants reported low confidence in their ability to read infographic texts, with 48% of participants (N=80) indicating the statement, "I am an expert at reading infographics," was very untrue of them. Likewise, when presented with four infographic texts and asked to label them, "infographic" was the least common label for three of the four artifacts, suggesting difficulty with labeling infographics out of context as such. This idea is shared by other researchers, like Duke and Asher (2012), who noted that even tech-experienced students enter college underprepared for effectively using technology resources for their academic coursework, and Hattwig, Bussert, Medaille, and Burgess (2013), who argued that even though the current generation of college students were likely to have many experiences participating in a highly visual online culture, they do not necessarily have the skills to engage critically and effectively with multiple media in an academic environment.

However, all seven participants in the interview sample recognized their selected artifact as an infographic. Whereas Börner, et al. (2015) recognized that their participants' limited time attended to each of five data visualization artifacts might have been a limitation

of their study, the interview study for this dissertation involved concentrated time on a single infographic artifact. After obtaining demographic data and selecting an artifact for discussion, the interview commenced with an un-timed think-aloud protocol while the participant read and made sense of their selected artifact. Readers bring many traits to their reading of a text (Goffman, 1974; Carter, 2007), but it became apparent during the interview that some participants approached their infographic reading as they might approach a genre through the lens of their discipline or profession. This came through in the types of questions they asked, initial reactions to text features, and critiques/modifications suggestions to the artifact in front of them. One of the three, crucial characteristics that Wenger (2009) uses to identify communities of practice, like disciplines, is "practice," which he defines as "a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems" (pp. 1-2). One participant connected her infographic with her experience of the types of writing she had done previously to convey her historical research to a public audience. Other participants referenced infographics as useful pedagogical tools in the classes they teach, while yet others compared the story-telling tools on their infographic artifacts (i.e., visual metaphors, timelines, graphs, etc.) to the types and representations of tools preferred by practitioners of their disciplines. While there is not enough evidence to show that disciplinary expertise impacted their comprehension or correct labeling of a single infographic text, these results do suggest that more time with a single artifact, a think-aloud process, and recognition of infographics as corollary to other genres in their disciplines may have contributed to a more robust understanding.

The findings from this study support and build upon examples from literature where infographics are treated as disciplinary genres. Hall (2016) used action research to share

how infographics were used as an instructional resource for introducing core concepts and supplement additional course information to his undergraduate students. Polman and Gebre (2015) regarded infographics as "scientific inscriptions," capable of demonstrating students' science-learning to a public audience. The present study found that graduate and post-graduate participants, who teach or have taught undergraduate classes, viewed infographics as relevant instructional tools. Likewise, questionnaire participants reported encountering infographics as both reading and writing assignments in their recent academic classes.

There is some evidence from this research to support previous scholarship on infographics treated as a genre to foster public engagement with the discipline (e.g., Liu, 2013) and communicate research stories within communities of practice (e.g., Eodice, Geller, and Learner, 2017). The interview study included a participant who was looking to infographics as a genre capable of making her qualitative data useful to organizations that might benefit socially and politically from it. One of her challenges in executing this task, however, was her limited confidence, knowledge, and experience with creating infographics. Even though she had created them for other academic purposes, she was challenged by finding the right software, format, and design plan for communicating her abundant, qualitative data. This barrier echoes the work of Stones and Gent (2015), who found that infographic creation required particular skills in design, writing, and data that presented a difficult challenge to people who wanted to produce them. However, there were also participants in the present study who indicated that this genre would be inappropriate for communicating research stories within their disciplines, preferring instead more established genres traditionally accepted by certain practitioners of history, science, and religious

studies. In this way, infographics were treated as corollary (Yates & Orlikowski, 2007) to other genres in disciplines, rather than as potential boundary objects.

Limitations of the Study

There were several limitations to this study. These limitations are listed below:

1. The questionnaire study included a sample of undergraduate students who were enrolled in a credit-bearing subject pool for research in Psychology and Education. A majority of participants had declared one of those subjects as either their academic major or minor. Students' academic affiliations may have skewed the results (particularly about participants' encounters with infographics in academic classes) because these participants may have taken common academic classes.
2. The questionnaire study included a small sample size, limited to participants who were both enrolled in the subject pool and opted into this study from a list of options housed in a database. While it is not known what factors influenced participants' self-selection into this study, it is possible that this study may have attracted participants with an interest in its topic and scope, which may have also impacted the results.
3. The questionnaire study asked participants to self-report on the factors that supported or interfered with their comprehension of infographic artifacts. This is a different kind of assessment than an interpretive one where an evaluator would determine what features supported or interfered with a participant subject's comprehension. It is also different from a clinical study of participants' cognitive processing of infographic artifacts.

4. The interview study recruited a convenience sample of graduate and post-graduate participants when recruitment proved difficult during the pilot phase. The reason for low participation during the pilot phase was not clear, but correspondence with some participants suggested that it may have been an effect of the in-person time commitment for an interview, as well as the voluntary nature of participation in the interview study, which did not include compensation.
5. A central premise underlying this study was that infographics are a broad and emergent genre. However, the questionnaire study contained a limited sample of twelve infographics, representing a range of types and topics. Likewise, the interview study contained a limited corpus of five infographics, from which participants selected only one to examine further for the interview. Future studies of familiarity with infographics might include a much broader range of artifacts, and future studies of aspects of infographic literacy might include more than one artifact for discourse-based interviews.
6. The research was facilitated, coded, and reported by a single researcher, so interrater reliability was not achieved for coding narrative questionnaire and interview responses. Future studies could replicate the design but develop a more reliable coding and reporting process.

Theoretical Implications of the Results

Two theoretical perspectives framed this study. *Communities of practice* (Wenger, McDermontt, & Snyder, 2002; Wenger, 2009) and *genre* theory (Bazerman, 2014; Carter, 2007; Schryer, 2002; Yates & Orlikowski, 2007) informed questions related to the roles, features, and functions of infographics in academic contexts and other systems of social

activity. The findings from this study highlight pedagogical and genre design tensions, and may suggest opportunities for instructional development that attends to considerations for evaluating instructional materials and modeling processes and practices for interpreting and creating infographic texts.

Participants in the interview study tended to confirm the popular approach of using infographics as a boundary object (Schryer, 2002) between disciplines and different types of public audiences—learners, organizations, and interested individuals. The idea of visual approaches to teaching and learning is not new (Avgerinou & Ericson, 1997; Heinich, Molenda, & Russell, 1982; Marcel, 2014). Literacy scholar, Patricia Edwards (2010), argued, "Visual literacy stems from the notion of images and symbols that can be read. Meaning is communicated through image more readily than print, which makes visual literacy a powerful teaching tool" (p. 22). However, this study found that the current, common, "stable for now" (Yates & Orlikowski, 2007, citing Schryer, 1993) genre of infographics contains more than readable images and symbols. Some infographics contain aesthetic design elements and some contain visual representations of quantitative data. Some combine data visualizations into a singular representation, and some use rhetorical devices to add an additional layer of meaning to the visual. Thus, the literacy demands of infographic texts might, in fact, be greater than other types of visual texts, including their corollaries—texts like PowerPoint slides in lectures, traditional bar graphs, timelines, or diagrams, etc. The cognitive demands of interpreting graph or process data in concert with metaphors, analogies, or varied reading paths may be in tension with an infographic's intended purpose of communicating information in an efficient and widely consumable way.

Disciplines have traditions for communicating and reifying knowledge within and without their communities. Bazerman (2014) refers to the communicative acts circulated within these communities as *genre*, coordinated and produced by ongoing activity between and among members. Likewise, Carter (2007) describes ways of knowing, thinking, and doing as inscribed in the genre practices within disciplines. Participants in the interview study recognized some features of infographic artifacts as familiar, but distorted, representations—or corollaries—of information that might occur in their disciplines. For example, doctoral students in history, religious studies, and environmental science recognized timelines and bar charts as common visuals in their disciplines, but also noted that practitioners of their disciplines would be unlikely to represent information infographically to members within the discipline, even if they would use similar representations to teach students or communicate with the public.

Knowing when and how it would be appropriate to experiment with genre—to introduce or use a corollary genre in a rhetorical situation—requires certain, situated expertise about text practices in a community of practice. In the interview study, we heard the doctoral student in religious studies completing his think-aloud protocol and trying to make sense of *when* or *for what purpose* he might see information presented in infographic form. In the context of the interview, he was supposing this information as one strategy he employed to make sense of the "Genderbread" infographic artifact with which he had been presented for the discourse-based interview. He said:

> So, I'm trying to understand firstly, what is this presentation for? Like who is the audience? Is it for a class presentation or is it, say, a part of someone's dissertation or

thesis to kind of explain, 'Okay, this is what I've done, like these are my findings, or this is my intervention, theoretical intervention of understanding gender.'

Trying to locate this genre within his organizing schema for academic work, this participant illustrated two ideas: First, he recognized that there might be a context in which such an infographic *could* serve as an acceptable genre for delivering information for a presentation of research (i.e., for a class presentation or thesis), corollary to another visual form, like a PowerPoint presentation, research poster, or summarizing graphic. Second, his struggle with locating this genre in a rhetorical situation, as well as the critique he offered of his artifact, suggest that this genre might *not always* be an appropriate genre for communicating academic research. Given that these might be tacit boundaries of appropriate use, a more veteran member of a community of practice might be better-positioned than a junior member to introduce corollary genres.

And yet, results from both the questionnaire and interview studies confirmed the trend of infographics used as pedagogical devices. These findings suggest that more can be done to teach learning audiences the processes and practices of interpreting and representing information in disciplines, and that instructors should reconsider the affordances of infographics as instructional devices and reexamine their own roles in modeling for students the processes and practices of interpreting and representing information in their disciplines. As disciplines seek to educate public and learning audiences alike, infographics have become a popular vehicle for this effort, an idea that was reinforced by the findings from this study. However, this paradigm is reminiscent of an assumption about graphics noticed by Tufte (1983) in his somewhat scathing view of decorated visual graphics functioning as, "[…] mainly devices for showing the obvious to the ignorant" (p. 53). He writes:

> The assumption led down two fruitless paths during the graphically barren years from 1930 to 1970: First, graphics had to be "alive," "communicatively dynamic," over-decorated and exaggerated (otherwise all the dullards in the audience would fall asleep over those boring statistics). Second, that the main task of graphical analysis was to detect and denounce deception (the dullards could not protect themselves).

Unpacking these ideas—that graphics needed to entertain and maintain a reader's attention as well as communicate clearly in spite of a reader's familiarity with the topic or data—is reminiscent of the interview participants' rationale for representing disciplinary concepts and scholarship in infographic forms. Many of them agreed that a well-designed infographic would be comprehensible regardless of a reader's prior knowledge of the topic or experience reading infographics.

Tufte (1983) describes a consequence of assuming that visual, decorated graphics are useful learning tools. He notes, "Contempt for graphics and their audience, along with the lack of quantitative skills among illustrators, has deadly consequences for graphical work: over-decorated and simplistic designs, tiny data sets, and big lies" (p. 81). Instead, he advocates for a design that works to teach the processes and practices of the community in which the work is meant to circulate. He writes, "[…] for graphics in exploratory data analysis, words should tell the viewer *how* to read the design (if it's a technically complex arrangement) and not *what* to read in terms of content" (p. 182).

Given Tufte's recommendations for people seeking to educate, the results of this study have implications for members of disciplines as they move toward experimentation with infographics as boundary objects and corollary genres. Interview participants shared the popular view that infographics have potential for use in academic contexts and they

articulated confidence in their ability to read and interpret infographics easily, suggesting that an experienced or sophisticated reader can find ways to make sense of an infographic text. Questionnaire participants indicated lower confidence in their ability to read and understand or to create infographics, despite their frequent encounters with them in and out of school. These results suggest a pedagogical tension between what is *assigned* and what is *taught* in academic classes. Together with Tufte's critique of decorated graphics but recommendations for instructive design choices, these results have implications for communities of practice. That is, the use of infographic texts presents an *opportunity* for teaching processes and practices for interpreting and representing information in disciplines. If infographics are not widely consumable; but instead, they require more conceptual knowledge or skilled reading, then modeling ways of thinking about and working with visual representations of data might be achieved through what Lave and Wenger (1991) refer to as *legitimate, peripheral participation*, where members are enculturated into the ways of thinking and doing within a community of practice by learning alongside practitioners. Similar types of pre-/during-and post-reading strategies that are used to teach students how to read tables, charts, timelines, diagrams, research articles, textbooks, and other types of texts for academic purposes might need to be developed for infographic texts as well.

Speculations for an Emerging Genre

Results from this study open space to speculate about the future of infographic texts. As an emerging genre, infographics share similarities with PowerPoint slide presentations. Historically speaking, PowerPoint emerged and proliferated as a corollary genre to business presentations (Yates & Orlikowski, 2007), and have since become a common visual

accompaniment to other types of presentations, including instructional lectures and academic conference presentations. Likewise, the Introduction to this dissertation acknowledged infographics as an increasingly acceptable, "creative" alternative to traditional poster presentations or PowerPoint slide decks at academic conferences (Digital Humanities at Berkeley web site; MLA; Digital Frontiers, 2017) and participants in the interview referenced infographic visuals to accompany class lectures. The steady increase in infographic generators and templates over the last decade is reminiscent of the same template use that brought PowerPoints into presentation ubiquity in the decades prior.

In his essay, "The Cognitive Style of PowerPoint: Pitching Out Corrupts Within," Tufte (2003) outlines key problems related to the loss of information in PowerPoint slide decks, some of which include the following: 1) PowerPoints are low-resolution; 2) bulleted lists dilute thought; 3) templates stifle original style; 4) PowerPoint encourages poor data visualization practices; 5) other functions of PowerPoint hurt the audience. Informed by results from this dissertation study, my speculation about the future of infographics will draw from Tufte's key problems with PowerPoint.

PowerPoints are low-resolution. Tufte (2003) explains that PowerPoint presentations are meant to be projected on a wall, and are thus "very low resolution" (p. 2), allowing for only very little information to be housed on a single slide, and necessitating several slides to deliver adequate information to a listening/viewing audience. Designed for delivery on a single slide or saved and shared most typically as a single image on a screen, infographics would seem like an answer to this problem. However, at least two of the infographics used in this study ("History of Computer Science" and "Tracking Trump's Nominations") required continuous scrolling down the page in order to view all of the information in them.

During the pilot phase of this dissertation, some participants experienced difficulty reading the infographics when those images were zoomed out to fit the screens on their devices, prompting a revision to the selection criteria applied to infographics used in the final study. Information still needs space, whether it is a scrollable screen or several slides, so Tufte's problem with low-resolution projections remain relevant to infographics, as well.

Bulleted lists dilute thought. Tufte's (2003) primary critique of bulleted lists in PowerPoints is that they give the appearance of organized information, but they leave out logical reasoning. This idea is reminiscent of the complaints made by questionnaire participants about the "Globalization" infographic, which was most often ranked as the most difficult artifact to read and understand. This infographic, which included circles with numbers that represented incarceration rates in particular countries, was missing key contextual information to help readers understand the reasoning represented in the image. Likewise, all of the infographics used in this study contained highly visual information, organized by spatial separations when there was more than a single idea represented. Consistent with Tufte's complaint about information lost, one could argue that unexplained assumptions are likewise present in infographic texts.

Templates stifle original style. Although templates are intended to support users who might benefit from an aesthetically pleasing presentation theme or a consistent organizational design, Tufte (2003) refers to these as "distinctive and peculiar," as well as "sad realities" (p.12) because they constrain the original style and detailed information that might be delivered in another manner. Evidence of this idea of constraint was present in the interview study, in which a doctoral candidate in history struggled with how to represent her dense, qualitative data in an infographic text. She acknowledged, "It's the question of what

to include and what not to include that is so hard," and later, "That's one thing that I find as a humanist-slash-historian: that it's not always easy to quantify what you want to show."

PowerPoint encourages poor data visualization practices. Tufte's (2003) primary complaints about poor data visualization practices in PowerPoint presentations are that large data gets segmented into multiple slides and that PowerPoint chart wizards encourage "chartjunk," including incorrect, misleading, and overdesigned information. Infographics are highly vulnerable to chartjunk, evidenced in the study by atypical timelines (e.g., "History of Computer Science" infographic) and misleading visual metaphors (e.g., "Bankruptcies" infographic). Whereas PowerPoints might require breaking data into multiple slides, one infographic in the interview study ("Bankruptcies" infographic) combined timeline and bar chart information into a single image, and an infographic in the questionnaire study ("Quitting Smoking" infographic) combined diagram and timeline data into a single image. This combining of data in a single visualization or inclusion of multiple visualization types on a single infographic text is reminiscent of the data visualization practices Tufte laments.

Other functions of PowerPoint hurt the audience. Tufte (2003) notes that PowerPoint slides serve other functions than just accompanying oral presentations. Such uses include printed on paper as notes or reports, attached to emails, or circulated on the internet (p. 20). In these formats, Tufte suggests that the problems with PowerPoints are intensified, as readers are left to leaf through pages of decontextualized, "intellectually thin" information. In the questionnaire study, participants reported regularly encountering infographic texts as posters, printed advertising, online and television news elements, and social media posts, in addition to the academic contexts in which they reported encountering them. Despite this high-frequency exposure, these participants tended to rate their expertise in reading and

comprehending infographics to be low. This might raise the question about whether more needs to be done to teach people how to better read or create infographic texts (or both).

The results from this study support Tufte's (2003) critique of PowerPoint presentations and portend a similar fate for this genre as it continues to proliferate in academic contexts as reading/writing assignments and acceptable corollaries to traditional, visual presentation formats. Tufte's answer to these problems, though, may be instructive for users of infographics, as well:

> Designer formats will not salvage weak content. If your numbers are boring, then you've got the wrong numbers. If your words or images are not on point, making them dance in color won't make them relevant. Audience boredom is usually a content failure, not a decoration failure (p.22).

If infographics, like PowerPoint presentations, are here to stay for a while and if these speculations about the genre, consistent with the findings from this dissertation, hold true, then there are implications for professional practice as well.

Implications of the Results for Professional Practice

This study provided a case for considering, more broadly, what kinds of experiences and familiarity people have with infographics, particularly as infographics continue to spread in ubiquity and evolve as a genre. It also examined aspects of a literacy of infographics, including features common to the emergent genre as well as mediating factors, like academic domain, elements of design, and central topic or story. The findings suggest that undergraduates and post-graduates, alike, encounter infographics in the news, on social media, around campus and community, and in academic classes. However, *assigning* reading and writing in a genre like an infographic is not equivalent to *teaching* students how

to do either of the following: 1) read and/or write an infographic genre; 2) read and/or write with the conventions of a discipline.

The results of this study suggest that the increasing ubiquity of infographic genres is making its way into higher education contexts. A majority of undergraduate students in the questionnaire study indicated frequent encounters with infographics in their academic classes, including those assigned as readings and or writing projects in at least one of their three most recent classes. Likewise, two interview participants indicated that they had used infographics as instructional devices in undergraduate classes they taught, and at least two more participants included ways that they had used or wanted to use infographic genres to communicate results of recent scholarly research. The increased use of infographic texts as boundary objects between a learning audience and a discipline, as well as the use of infographic texts in disciplines as corollary to more traditional or established genres, may be transforming the nature of instructional design and delivery in academic courses. This implication encourages a rethinking of the ways instructors evaluate texts for use in their courses as well as how they connect such texts beyond the content or topic to the processes and practices of the discipline.

This study has implications for instructors who assign infographic texts as reading and writing assignments in their academic courses, as well as for anyone who creates infographics as educational resources. Assigning infographics as readings does not teach students how to read infographic texts. In the questionnaire study, one of the infographic artifacts was selected from a free, publicly available sample chapter of an online sociology textbook. The infographic, "Globalization by the Numbers," represented the front matter as introductory matter for a chapter. As educational material, this infographic would

presumably function to communicate instructional material in a visual way conducive to student learning. However, students' familiarity with information presented this way trended toward the negative, with 57% of participants (N=80) indicating that they were not at all or slightly familiar. In addition to participants' lack of familiarity with information presented this way, this infographic received the lowest ranking when asked to order a corpus of four infographics by how easy they were to read and understand. 33% of participants (N=80) gave this infographic a rank of 4, meaning that it was their most difficult of the four artifacts to read and understand, citing elements of design and reader experience as primary factors in this ranking. Adding barbed wire to the scatter plot chart in that infographic did not make it more comprehensible to participants, just as Tufte (1983) noted, "Graphics do not become attractive and interesting through the addition of ornamental hatching and false perspectives to a few bars" (p. 121). As an informal usability test of an educational resource, the findings from this study suggest that the "Globalization" infographic was limited as a stand-alone artifact. Understanding the literacy needs of students who are learning to read and produce infographic texts for academic purposes will be key to designing curriculum that includes such texts.

This study exposed gaps between how some instructors view the affordances of infographics as pedagogical devices and the infographic literacy needs of students. Gaps may signal a need for instructional development in the selection and uses of infographic texts for academic purposes; but moreover, a need for instructional development in modeling and making explicit the ways of knowing, doing, and writing in disciplines (Carter, 2007; Bazerman, 2009). Especially as members within particular communities of practice continue to appropriate infographic texts for communicating research stories, and

the genre continues to emerge, those processes and practices may prove troublesome (Perkins, 2009) to students trying to learn the content and genre systems in disciplines.

Finally, with the growing trend of online and blended course offerings in institutions of higher education, instructors and instructional designers are looking to visual texts, like infographics, as visual alternatives to alphabetic texts delivered online (Dunlap & Lowenthal, 2016). Despite an abundance of literature on visual and multimedia literacies, as well as an increased use of infographics in educational contexts, there is more work to do in order to understand how and when infographics can be used as effective texts for receptive (reading) and expressive (writing tasks). That is, instructors of online and blended courses that incorporate infographics courses will need to consider what supplemental information or interaction with an infographic text is necessary in order for a student to read and comprehend the text in service of the course's learning objectives, and what skills or knowledge beyond the technical procedures for creating an infographic in a generator web site are necessary in order for students to create such texts.

Recommendations for Further Research

Several opportunities exist for further research. First, as demonstrated in the review of literature and infographic framework, there are many different types, styles, and purposes for infographics. Some infographics depict processes while others report a data-driven story. Some include functional design elements, while others include decorative ones. Some combine multiple data visualization techniques while others design around one. Future research could model more closely the work of Börner, Maltese, Balliet, & Heimlich (2015), who narrowed the corpus of data visualizations to five different types, and who tested

particular aspects of data visualization literacy by coding for correctness, a technique also employed by Boy, Rensink, Bertini, Fekete (2013) to assess visualization literacy.

Future studies may also consider expanding participation from a human subjects pool to a broader sample. Because the study seeks to understand participants' familiarity with infographics in a variety of contexts, better participation from the greater campus community or even across campuses would provide additional insight about the ubiquity and uses of infographics in and out of the academy and could be disaggregated by certain variables like academic major, year in school, etc. Such a study will contribute to conversations from previous scholarship on visualization literacy and inform faculty development efforts around teaching and learning with unfamiliar genres.

A future interview study could more closely examine factors that instructors use when selecting infographics as pedagogical devices to accompany lectures, assign as readings, and require as products of student learning. This study found that interview participants critiqued infographics as simplifications or destructions of established genres, like timelines and bar graphs. They also lauded infographics as instructional tools capable of communicating complex ideas in an interesting, visual, and clever way to a wide, learning audience. A qualitative study that asks faculty to critically evaluate texts from their own teaching could build upon this finding and help develop a process for evaluating texts. Building upon this knowledge might have implications for faculty development efforts around teaching for disciplinary literacies, as well.

While this study identified some ways that infographics are used in academic courses and some perceived affordances of infographics as instructional tools, one potential case study could be situated in a class where infographics are used as pedagogical devices. A

study that explores the experiences of students who encounter infographic texts in the context of a particular course could build on knowledge about ways that students learn the processes and practices of disciplines, with additional implications for instructional design.

Conclusion

This conclusion begins with a story. In November 2017, when the Thomas Fire struck Ventura and Santa Barbara Counties, residents in those areas of California faced a lot of uncertainty: Which direction would the high winds take the fire next? Would their homes be spared from the flames? Was it safe to go outside without a mask to protect their lungs from the smoke and ash? With the rain not far behind, would they be safe from the eventual mud slides? When and how could they get to work? Where could they go and what could they do once displaced, and for how long? What resources did they need and where could they get them for their families? These were just some of the questions circulating community discourse, but people clung to their televisions, computers, and cell phones waiting and looking for answers.

On social media, a community group, called "Thomas Fire Info," was started by Greg Gillis-Smith, a Ventura County resident with construction experience, fire training, and research and communication skills (Waite, 2018). The group quickly grew to over 21,000 members and became a hub of updates on fire, weather, aid, and other resources. Gillis-Smith regularly posted long, detailed analyses of weather maps, predictive models, and geographical data. Including those same data sources in his posts, he urged people to learn how to read and interpret this data for themselves; that they should not rely on his or anyone else's analyses and predictions. On March 19, 2018, accompanied by twelve maps, charts, and data tables, his post began:

> I am going to tell you what you need to hear, not what you want to hear. First, you need to take responsibility for learning how to read maps, weather, and operate web sites so that you can take care of yourselves and families. I will provide the tools you need to take it from there. I cannot believe the number of adults who have said, "I don't know how to read that. Can you interpret it for me?"

His post continued for thirteen paragraphs—unconventionally long for social media writing—explaining to people how to locate, read, and interpret information, and why the pump of moisture headed to this part of Southern California was just as threatening as the previous weather event that had devastated Montecito with mudslides.

A member of the social media community entered the conversation with an infographic she had created in order to sort through the inundation of information and communicate the basic things she thought people needed to know in order to prepare for this emergency. In the same way that Gillis-Smith's posts received intense reactions from community members—likes, comments, shares, questions—her post received near silence. As well-intentioned as her post may have been, her attempt to clarify complicated and complex data through an infographic genre as either a boundary object between an environmental science community and an interested public, or as a corollary genre to traditional maps and charts, was not received with the same kind of intense responses of gratitude and follow-up that Gillis-Smith's posts had received. Certainly, Gillis-Smith had built an ethos since creating the social media group, and it is unclear why the infographic was not well-received, but the results of the two studies for this dissertation *suggest* that infographics are not adequate replacements for data literacy and disciplinary processes and practices, as much as they are treated as ubiquitous genres that anyone can read and

understand and as pedagogical devices capable of communicating complex content to a wide audience.

This anecdote relays a version of the picture emerging from the results of this study. First, participants in both the questionnaire and interview studies confirmed that they do encounter infographics in the news, on social media, in advertising, and increasingly in academic contexts. Infographic generators and templates, like Canva and Piktochart, make the act of creating infographics easier than it used to be, moving the limits of authorship from graphic designers and data scientists to potentially any user with information and internet. For the social media participant in this closing anecdote, it would not have been difficult to locate an online tool to house, compose, publish, and share the environmental science information Gillis-Smith pointed out that people were struggling to understand.

Next, from the perspective of someone with complex data, infographics were recognized for their affordances in conveying a story or process in a visual, broadly consumable way. Participants in the questionnaire study indicated that they encountered infographics as reading and/or writing assignments on a regular basis in their academic classes. Likewise, interview participants described infographics as useful instructional devices because of their ability to communicate nuanced disciplinary information in a widely consumable way, despite people's familiarity with the initial topic, and another interview participant looked to infographics as a possible genre for communicating her research story to organizations who could consume and use the information to advance their mission and interests. In that same vein, the social media participant may have recognized the affordances of the infographic genre for demystifying complicated graphs, charts, and

weather data that was stymieing people's important decision-making processes during the Thomas Fire emergency.

At this point, however, the findings from this study reinforce the findings from other studies of quantitative and visual literacy. Participants in the questionnaire study indicated low agreement with statements of expertise in reading or creating infographics. Their narrative responses indicated confusion and distraction from design elements and uncertainty about how to read the information visualized, even in an infographic originally housed as educational front matter for an electronic textbook chapter. Interview participants uncovered more information the longer they spent looking at, noticing, and thinking aloud about particular elements of their selected infographic artifacts. Though one cannot draw reliable conclusions from the social media silence in response to the Thomas Fire infographic from the anecdote, it is reasonable to speculate that the infographic did not function as antidote for a lack of data literacy and weather model knowledge. It was unsuccessful as a boundary object between an environmental science community and an interested public. It was also rejected as a corollary to the same traditional representations of information people were struggling to understand. That is, people seemed to prefer lengthy descriptions of traditional charts and maps to reorganized information represented in a derivative genre.

While infographics may continue to grow in public consumption and dissemination, with potential for academic purposes as well, this study shows that the diffusion of infographic genres into academic contexts is potentially creating pedagogical tensions. Infographic generators and templates make this genre easier for developing writers to create, but these writers still need to be taught the processes and practices for communicating ideas

effectively in their disciplines. Likewise, infographics have perceived affordances as pedagogical tools for a learning audience to read and interpret, but this same audience still needs to be taught the processes and practices for reading and interpreting information in their disciplines. As infographics continue to emerge as a genre and show more promise for appropriation by disciplines, an awareness of the literacy needs of readers and writers of these texts will be central to their effectiveness in educational contexts.

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APPENDIX A. HUMAN SUBJECTS APPROVAL

UNIVERSITY OF CALIFORNIA

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FWA#00006361

Office of Research
Human Subjects Committee
Santa Barbara, CA 93106-2050

Web: http://www.research.ucsb.edu

07/20/2018

VERIFICATION OF ACTION BY THE UCSB HUMAN SUBJECTS COMMITTEE

RE: HUMAN SUBJECTS PROJECT NUMBER 22

FROM: UCSB HUMAN SUBJECTS COMMITTEE

PROTOCOL NUMBER 22-18-0546

TYPE: EXPEDITED REVIEW

TITLE(S):

Reading Infographics: A Study of InfoVisual Meaning-Making and Situated Expertise

INVESTIGATORS:

Karen Lunsford

Lorna Gonzalez

The above identified protocol may commence on 07/20/2018. This protocol will expire on 07/20/2019

The research activities under this submission present no more than minimal risk to the human subject participants and involve only procedures listed in one or more of the following Categories eligible for Expedited Review under the Federal Regulations at 45 CFR 46.110: 6,7

AMENDMENTS/MODIFICATIONS/CHANGES:
Any change in the design, conduct, or key personnel of this research must be reviewed by the UCSB HSC prior to implementation.

UNANTICIPATED PROBLEMS/ADVERSE EVENTS:
If any study subject experiences an unanticipated problem involving risk to subjects or others, and/or a serious adverse event, the UCSB HSC must be informed promptly. An e-mail or phone call must be received within 7 days. Further reporting requirements will be determined by the UCSB HSC at that time.

RECORDS RETENTION REQUIREMENTS:
Please remember that signed consent forms must be maintained for a minimum of ten years past the completion of this research. Additional requirements may be imposed by your funding agency, your department, or other entities.

CONTINUING REVIEW REQUIREMENTS:
To ensure that your research can continue uninterrupted, it is recommended to follow the schedule for Continuing Review:
Expedited Review: Submit renewal at least 3 weeks prior to the protocol's expiration date.

If your renewal submission increases the risk to human subjects, then the protocol may be reviewed by Full Board Review. Go to the Office of Research website for the most current submission deadlines:
http://www.research.ucsb.edu/compliance/human-subjects/submission-timelines/

APPENDIX B. QUESTIONNAIRE INSTRUMENT

Alignment of Survey Questions to Research Questions

Research Questions Addressed by Each Survey Question
Q# = Survey Question Number; RQ = Research Question

Q#	Question Text	RQ
2.2	What is your age?	1, 3
2.3	What is your gender?	n/a
2.4	What is your UCSB status?	1, 2b, 2c, 3
2.5	What is your undergraduate status?	1, 2b, 2c, 3
2.6	Major or Home Department at UCSB	1, 2a, 2b, 2c, 3
2.7	If you have a double major or second department at UCSB…	
2.8	The language you are most comfortable with is	Pre-screen
2.10 2.15 2.20 2.25	IG: Tracking Trump's Nominations IG: Dengue Virus IG: Globalization by the Numbers IG: How Quitting Smoking Changes Your Body	n/a
2.11 2.16 2.21 2.26	How familiar are you with this **TYPE** of data presentation?	1, 3
2.12 2.17 2.22 2.27	Where have you encountered information presented **like** this (select all that apply)?	1, 2c, 3
2.13 2.18 2.23 2.28	In which class or classes have you encountered information presented like this?	1, 2c, 3
2.14 2.19 2.24 2.29	What would you call this **TYPE** of data presentation?	1, 2a, 2b, 3
2.31	Tell us how easy these data presentations are to understand. Drag and place these images in order to rank them vertically from easiest to read and understand (1) to most difficult to read and understand (4).	1, 2b, 3
2.32-2.35	Why did you select this data presentation as the **easiest** to read and understand? What elements of this presentation aid your understanding, and what other factors contributed to the rank you gave this item (e.g., knowledge about the topic; seen this presentation before, etc.)?	1, 2a, 2b, 3
2.36-2.39	Why did you select this data presentation as the **most difficult** to read and understand? What elements of this presentation impacted your understanding, and what other factors contributed to the rank you gave this item (e.g., knowledge about the topic, information layout, etc.)?	1, 2a, 2b, 3
3.2	Define infographics.	1, 2a, 3
3.3	Please indicate your response to the following statements: I encounter infographics in the courses I take or teach. I encounter infographics on social media. I encounter infographics in the news.	1, 3
3.4	Have you encountered infographics elsewhere? Please explain.	1, 3
3.5	As best you can, sort these eight items into two categories: 1) Infographics; 2) NOT infographics.	1, 2a, 3

3.6	Indicate the extent to which the following statements reflect you. I am an **expert** at **reading** infographics. I am an **expert** at **creating** infographics.	1, 3
3.7	As best as you can remember, what were the **last three (3) classes** you took as a student AND/OR taught as an instructor/TA?	2b
3.8	In any one of your three most recent classes, did you encounter infographics? Yes, **read** one/some Yes, **made** one/some No	1, 2a, 2b, 2c, 3
5.1	We would love to talk with you more about your experience. **If you would be willing to participate in a short interview, please enter your email address and a researcher will contact you to set up a meeting.** Thank you for taking time to participate in this study.	n/a

APPENDIX C. QUESTIONNAIRE PILOT USABILITY TEST

Thank you for agreeing to pilot my dissertation research materials. Please read these materials **both** as a hypothetical participant in this study and also as the student-researcher that you are. I am asking you to provide **feedback on your experience as a participant** AND **suggestions based on your research experience**. Be as honest and detailed as possible in your feedback.

Task 1. Answer the questionnaire

1. Go to [Web Link]
2. Click the *Consent* button and continue to the survey.
3. Answer the demographic questions on the first page.

Feedback: Were any of the questions confusing to you? What changes would you make to this section (look & feel, question wording, etc.)?

4. Click *Continue* to move on to the next page.
5. Answer the Experience and Perception questions on the second page.

Feedback: Were any of the questions confusing to you? What changes would you make to this section (look & feel, question wording, etc.)?

6. Click *Continue* to move on to the next page.
7. Select *Yes* from the drop-down menu to continue to Task 2. Online Sorting Activity

Task 2. Complete the online sorting activity

1. Read the directions and watch the instructional video.

Feedback on the instructional video: Feedback on the written directions:

2. Please set a timer before you begin the sorting activity (hyperlinked timer)
3. As best you can, complete the sorting activity.

Feedback on the sorting activity: What was easy? What was difficult or frustrating? What was confusing? Suggestions?

APPENDIX D. INTERVIEW PROTOCOL

Interview Questions

1. [State year in school, department, major course of study]

2. As you read this item, think aloud to express your understanding.

    a. What impressions do you have as you read?

    b. What strategies are you using/did you use to make sense of this?

3. What would you call this type of data presentation?

    a. What features signaled to you that this is [what you called it]?

4. Where have you seen data presentations like this before?

    a. How expert do you consider yourself at reading information presented this way? Why do you think so?

    b. How expert do you consider yourself at making data presentations like this?

5. What do you think is the purpose of presenting information in this way? Why would someone choose to present information this way versus some other way?

6. What would you say is the topic of this presentation? How familiar are you with the topic presented in this/these presentations?

7. Critically appraise: What is done well in this presentation?

8. What modifications would you make to this presentation?

APPENDIX E. QUICK-REFERENCE TABLES OF INFOGRAPHICS

Infographics used for questionnaire study, Section 2

Published Title	Brief Description	URL	Short Title
Tracking how many key positions Trump has filled so far	Number of presidential appointments in various stages of nomination since taking presidential office, compared with 4 previous presidents	https://www.washingtonpost.com/graphics/politics/trump-administration-appointee-tracker/database/?utm_term=.704a5a7bb724	Tracking Trump's Nominations
Virus Trading Card: Dengue Virus	Diagram and features of dengue virus	http://tabletopwhale.com/page7/	Dengue Virus
Globalization by the Numbers: Incarceration Rates	Comparison of incarceration rates in 15 countries	http://www.wwnorton.com/college/soc/essoc5/animations/incarceration/	Globalization by the Numbers
How Quitting Smoking Changes Your Body: Effects of Quitting Smoking	Timeline and color-coded diagram of health effects from smoking cessation from 20 minutes to 15 years	https://visual.ly/m/design-portfolio/effects-of-quitting-smoking-cvs/	Quitting Smoking

Infographics used for interview study

Published Title	Brief Description	URL	Short Title
A Brief History of Computer Science	Timeline of Computer Science people and innovations between 2300 B.C. and 2012	https://visual.ly/community/infographic/computers/brief-history-computer-science	History of CS
The Genderbread Person v3.3	Elements of gender and their spectra	http://itspronouncedmetrosexual.com/2015/03/the-genderbread-person-v3/	Genderbread Person
An animated chart of 42 North American butterflies	Field guide chart of 42 butterfly species illustrations	http://tabletopwhale.com/2014/08/27/42-butterflies-of-north-america.html	Butterflies
Transparency: The Largest Bankruptcies in History	Timeline and comparison of large companies that filed for bankruptcy between 1987-2009	https://www.good.is/infographics/transparency-the-largest-bankruptcies-in-history#open	Bankruptcies
Who Shot Ya? How Emergency Departments Can Collect Reliable Policing Shooting Data	Research study of attitudinal, logistical, ethical, and legal factors related to the collection of police shooting data from hospital staff	https://www.blackfeminisms.com/wp-content/uploads/2016/09/Richardson-et-al-2016.pdf	Who Shot Ya?